B.E. (Mechanical Engineering)

CURRICULUM AND SYLLABUS HANDBOOK
Regulation 2019 (Revised)

Approved by Academic Council on 14.10.2024

2024-2025

Sri Eshwar College of Engineering
Coimbatore | Tamilnadu
An Autonomous Institution
Affiliated to Anna University, Chennai

Chairman - Board of Studies
Department of Mechanical Engineering
Sri Eshwar College of Engineering (Autonomous)
Kinathukadavu, Coimbatore - 641 202.

1.0 Vision, Mission and Core Values of the Institution

Vision

"To be recognized as a premier institution, grooming students into globally acknowledged engineering professionals."

Mission

We will achieve the Vision by:

- ✓ Providing outcome and value-based engineering education
- ✓ Nurturing research and entrepreneurial culture
- ✓ Enabling students to be industry-ready and fulfil their career aspirations
- ✓ Grooming students through behavioural and leadership training programs
- ✓ Making students socially responsible

Core Values

The following core values of Sri Eshwar College of Engineering are closely aligned with its vision and mission, supporting the college's goal of developing well-rounded, globally capable, and socially responsible engineering professionals:

1. Pursuit of Excellence,
2. Problem Solving Mindset
3. Spirit of Collaboration
4. Culture of Innovation
5. Responsibility to Society

2.0 Vision and Mission of the Department of Mechanical Engineering

Vision

"To become an integrated centre of excellence focusing on design, manufacturing, and industrial engineering, providing societal benefits through academic services including research and innovation."

Mission

M1: Develop curriculum and delivery approach ensuing horizontal exposure and vertical expertise to the learners.

M2: Provide opportunities for faculties to enrich their knowledge and skills.

M3: Establish connections for local, national and global expertise for an active enhanced learning environment.

M4: Execute societal outreach activity providing solutions to industries and society

M5: Establish contemporary facilities for providing practical learning experience.

3.0 B.E. (Mech.) Programme Educational Objectives (PEOs)

PEO1: Graduates will take up careers in Mechanical Engineering fields like Manufacturing, Design, and Thermal and involve in carrying out mechanical engineering products.

PEO2: Graduates will engage in a post graduate program in the field of Engineering Design leading to academic and research careers.

PEO3: Graduates will take up entrepreneurship as a career.

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4.0 Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

5.0 B.E. (Mech.) Program Outcomes (POs)

PO1: **Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialisation as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: **Problem Analysis**: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: **Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: **Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: **Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

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PO6: **The Engineer and The World**: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to the economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: **Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: **Individual and Collaborative Teamwork**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: **Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: **Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: **Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

6.0 B.E. (Mech.) Programme Specific Outcomes (PSOs)

PSO1: Apply contemporary approaches in the field of manufacturing and design

PSO2: Apply concepts and approaches for improving the productivity in a professional working environment

7.0 B.E. (Mech.) Program Curriculum

7.1. Curriculum Structure

The curriculum structure includes the following course categories:

Humanities and Social Sciences (HS): Technical English, Foreign Languages, Management & Engineering Ethics, and Engineering Economics.

Basic Sciences (BS): Mathematics, Physics, and Chemistry.

Engineering Sciences (ES): Materials Science, Workshop Practices, Drawing, and Fundamentals of Electrical, Electronics, Mechanical, and Computer Engineering.

Professional Core (PC): Courses specific to the chosen specialisation or branch.

Professional Electives (PE): Elective courses within the chosen specialisation (Vertical).

Open Electives (OE): Courses from other technical or emerging subject areas.

Project Work (PW): Projects involving Design Thinking (Product/Software Development Life Cycle), Innovative/Multidisciplinary Projects, Industry Projects, and other project work.

Employability Enhancement Courses (EM): Personality Development, Verbal and Soft Skills, Advanced Logical Thinking, and Industry or External Internships.

Mandatory Courses (MC): Heritage of Tamils (**HSMC**), Tamils and Technology (**HSMC**), Environmental Science, and Universal Human Values.

Optional Courses (OC): NCC Credit Course Level I, NCC Credit Course Level II, NCC Credit Course Level III and Honours Courses.

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Student Induction Programme (SIP)

The Student Induction Programme (SIP) is an essential three-week orientation tailored for first-year undergraduate students enrolled in BE/B.Tech programs. Held annually, this programme is designed to facilitate a smooth transition from secondary education to collegiate life, ensuring that students effectively integrate into both the academic and social environments of the institution.

Program Components

- ✓ Universal Human Values
- ✓ Health
- ✓ Department Familiarization
- ✓ Interactive Lectures
- ✓ Proficiency Modules
- ✓ Local Visits
- ✓ Cultural Activities

The SIP plays a pivotal role in setting the stage for a successful and fulfilling college experience, providing students with the tools and support necessary for a smooth transition into their academic and social life.

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7.2. B.E (Mech.) - Curriculum

Outcome-Based Education (OBE) with Choice-Based Credit System (CBCS).

Regulation 2019 (Revised)

SEMESTER I

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
	-	Induction Program	-	-	-	-	-	-
1	R19MA101	Matrix Algebra and Calculus	BS	3	1	0	4	4
2	R19CY101	Engineering Chemistry	BS	3	0	0	3	3
3	R19CS101	Problem Solving using C	ES	3	0	0	3	3
4	R19ME101	Engineering Graphics	ES	1	0	4	5	3
5	R19ME102	Engineering Mechanics	PC	3	1	0	4	4
Theory cum Practical Course								
6	R19HS151	Technical English	HS	2	0	2	4	3
Practical Courses								
7	R19CY111	Chemistry Laboratory	BS	0	0	2	2	1
8	R19GE111	Engineering Practices Laboratory	ES	0	0	4	4	2
9	R19CS111	Problem Solving using C Laboratory	ES	0	0	4	4	2
Professional Development Course								
10	R19EM101	Soft Skills	EM	0	0	2	2	1
		Total		15	2	18	35	26

SEMESTER II

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	R19MA102	Advanced Calculus and Complex Variables	BS	3	1	0	4	4
2	R19PH101	Engineering Physics	BS	3	0	0	3	3
3	R19CS103	Data Structures and Algorithms	ES	3	0	0	3	3
4	R19EC103	Electronics and Microprocessors	ES	3	0	0	3	3
Theory cum Practical Courses								
5	R19HS55X	Language Elective	HS	2	0	2	4	3
6	R19CS151	Python Programming	ES	3	0	2	5	4
Practical Courses								
7	R19PH111	Physics Laboratory	BS	0	0	2	2	1

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Sl. No.	Course Code	Course Name	Category	Periods/ Week L	T	P	Total Contact Periods	Credits
8	R19ME111	Computer Aided Drafting and Modelling Laboratory	PC	0	0	4	4	2
9	R19CS113	Data Structures and Algorithms Laboratory	ES	0	0	4	4	2
Mandatory Courses								
10	R19MC101	Heritage of Tamils / தமிழர்மரபு	HSMC	1	0	0	1	1
11	R19EM111	Technical Report Writing	EM	1	0	0	1	NC
		Total		19	1	14	34	26

SEMESTER III

Sl. No.	Course Code	Course Name	Category	Periods/ Week L	T	P	Total Contact Periods	Credits
Theory Courses								
1	R19MA204	Probability and Applied Statistics	BS	3	1	0	4	4
2	R19ME201	Engineering Materials and Metallurgy	PC	3	0	0	3	3
3	R19ME202	Manufacturing Technology	PC	3	0	0	3	3
4	R19ME203	Engineering Thermodynamics	PC	3	1	0	4	4
Theory cum Practical Courses								
5	R19ME251	Fluid Mechanics and Machinery	PC	3	0	2	5	4
6	R19XXXXX	Open Elective – I*	OE	2	0	2	4	3
Practical Courses								
7	R19ME211	Computer Aided Machine Drawing Laboratory	PC	0	0	2	2	1
8	R19ME212	Manufacturing Technology Laboratory	PC	0	0	2	2	1
Professional Development Course								
9	R19EM201	Logical Thinking	EM	0	0	2	2	1
Mandatory Course								
10	R19MC102	Tamils and Technology / தமிழரும் தொழில்நுட்பமும்	HSMC	0	0	1	1	1
		Total		17	2	11	30	25

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SEMESTER IV

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	**R19MA207**	Numerical Methods and Partial Differential Equations	**BS**	**3**	**1**	**0**	**4**	**4**
2	**R19ME206**	Kinematics of Machinery	**PC**	**3**	**0**	**0**	**3**	**3**
3	**R19ME207**	Thermal Engineering	**PC**	**3**	**1**	**0**	**4**	**4**
Theory cum Practical Courses								
4	**R19EC352**	Embedded Systems and IoT	**ES**	**3**	**0**	**2**	**5**	**4**
5	**R19ME252**	Strength of Materials	**PC**	**3**	**0**	**2**	**5**	**4**
6	**R19XXXXX**	Open Elective – II*	**OE**	**2**	**0**	**2**	**4**	**3**
Project Work								
7	**R19ME281**	Project with Design Thinking (Product / Software Development Life Cycle)	**PW**	**0**	**0**	**2**	**2**	**1**
Professional Development Courses								
8	**R19EM202**	Advanced Logical Thinking	**EM**	**0**	**0**	**2**	**2**	**1**
9	**R19EM203**	Summer Internship	**EM**	**-**	**-**	**-**	**-**	**NC**
Mandatory Courses								
10	**R19MC202**	Indian Constitution and Tradition	**MC**	**1**	**0**	**0**	**1**	**NC**
		Total		**18**	**2**	**10**	**30**	**24**

SEMESTER V

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	**R19ME301**	Engineering Metrology and Measurements	**PC**	**3**	**0**	**0**	**3**	**3**
2	**R19ME302**	Dynamics of Machines	**PC**	**3**	**0**	**0**	**3**	**3**
3	**R19ME303**	Heat and Mass Transfer	**PC**	**3**	**1**	**0**	**4**	**4**
3	**R19ME304**	Machine Design	**PC**	**3**	**1**	**0**	**4**	**4**
4	**R19ME5XX**	Professional Elective I	**PE**	**3**	**0**	**0**	**3**	**3**
Practical Courses								
5	**R19ME311**	Metrology and Dynamics Laboratory	**PC**	**0**	**0**	**4**	**4**	**2**

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Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
6	R19ME312	Thermal Engineering Laboratory	PC	0	0	2	2	1
7	R19ME313	CAD/CAM Laboratory	PC	0	0	2	2	1
Professional Development Course								
8	R19MC201	Environmental Science	MC	1	0	0	2	NC
	Total			17	2	8	27	21

SEMESTER VI

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	R19AM303	Artificial Intelligence and Machine Learning	PC	3	0	0	3	3
2	R19ME305	Finite Element Analysis	PC	3	0	0	3	3
3	R19ME5XX	Professional Elective II	PE	3	0	0	3	3
4	R19ME5XX	Professional Elective III	PE	3	0	0	3	3
Theory cum Practical Course								
5	R19ME351	Fluid Power Systems and Industrial Automation	PC	2	0	2	4	3
Practical Courses								
6	R19AM312	Artificial Intelligence and Machine Learning Laboratory	PC	0	0	2	2	1
7	R19ME314	Computer Aided Simulation and Analysis Laboratory	PC	0	0	2	2	1
Project Work								
8	R19ME381	Innovative / Multi-Disciplinary Project	PW	0	0	2	2	1
	Total			14	0	8	22	18

SEMESTER VII

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	R19HS401	Principles of Management and Professional Ethics	HS	3	0	0	3	3
2	R19ME401	Operations Research	PC	3	0	0	3	3
3	R19ME5XX	Professional Elective IV	PE	3	0	0	3	3

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Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Project Work								
4	**R19ME481**	Project Work – Phase I	PW	**0**	**0**	**6**	**6**	**3**
Total				**9**	**0**	**6**	**15**	**12**

SEMESTER VIII

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Theory Courses								
1	**R19XXXXX**	Open Elective – III*	OE	**2**	**0**	**2**	**4**	**3**
Project Work								
2	**R19ME482**	Project Work – Phase II	PW	**0**	**0**	**16**	**16**	**8**
Total				**2**	**0**	**18**	**20**	**11**

Total Number of Credits: 163

CREDIT SUMMARY *

Sl. No.	Course Category	Credits per Semester								Credits	Credit %
		I	II	III	IV	V	VI	VII	VIII		
1	**HS**	3	3	-	-	-	-	3	-	9	5.52
2	**BS**	8	8	4	4	-	-	-	-	24	14.72
3	**ES**	10	12	-	4	-	-	-	-	26	15.95
4	**PC**	4	2	16	11	18	11	3	-	65	39.88
5	**PE**	-	-	-	-	3	6	3	-	12	7.36
6	**OE**	-	-	3	3	-	-	-	3	9	5.52
7	**PW**	-	-	-	1	-	1	3	8	13	7.98
8	**EM**	1	-	1	1	-	-	-	-	3	1.84
9	**MC**	-	-	-	-	-	-	-	-	-	0.00
10	**HSMC**	-	1	1	-	-	-	-	-	2	1.23
Total		**26**	**26**	**25**	**24**	**21**	**18**	**12**	**11**	**163**	**100**

* Excluding Honours Courses

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7.3 Professional Elective Courses:

Vertical 1	Vertical 2	Vertical 3	Vertical 4	Vertical 5	Vertical 6	Vertical 7
ROBOTICS AND AUTOMATION	SMART MOBILITY SYSTEMS	DESIGN AND MANUFACTURING	DIGITAL AND GREEN MANUFACTURING	PRODUCT AND PROCESS DEVELOPMENT	GREEN ENERGY TECHNOLOGIES	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
R19ME511 Sensors and Instrumentation	R19ME521 Automobile Engineering	R19ME531 Robot and Machine Elements Design	R19ME541 Digital Manufacturing and IoT	R19ME551 Product Design and Development	R19ME561 Renewable Energy Technologies	R19ME571 Generative AI for Engineering Design
R19ME512 Electrical Drives and Actuators	R19ME522 Electric and Hybrid Vehicles	R19ME532 Computer Aided Design and Manufacturing	R19ME542 Robots and Systems in Smart Manufacturing	R19ME552 Robotic Process Automation	R19ME562 Energy Conservation in Industries	R19ME572 Machine Diagnostics and Condition Monitoring
R19ME513 Embedded Systems and Programming	R19ME523 Automotive Electronics	R19ME533 Design Concepts in Engineering	R19ME543 Industrial Robotics and Expert Systems	R19ME553 Additive Manufacturing	R19ME563 Energy Storage Devices	R19ME573 Exploratory Data Analysis and Visualization
R19ME514 Collaborative Robotics	R19ME524 Automotive System Modelling and Simulation	R19ME534 Non-traditional Machining Processes	R19ME544 Green Manufacturing Design and Practices	R19ME554 Total Quality Management	R19ME564 Equipment for Pollution Control	R19ME574 IoT Systems Design
R19ME515 Robot Kinematics and Dynamics	R19ME525 Vehicle Styling and Design	R19ME535 Rotating Machinery Design	R19ME545 Environment Sustainability and Impact Assessment	R19ME555 Design for Manufacturing and Assembly	R19ME565 Energy Efficient Buildings	R19ME575 Microsystems Design and Applications
R19ME516 Drone Technologies	R19ME526 Aircraft Mechatronics	R19ME536 Precision Manufacturing	R19ME546 Lean Manufacturing	R19ME556 Advanced Manufacturing Systems	R19ME566 Bioenergy Conversion Technologies	R19ME576 Machine Vision
R19ME517 Industry 4.0	R19ME527 Smart Mobility and Intelligent Vehicles	R19ME537 Failure Analysis and NDT Techniques	R19ME547 Green Supply Chain Management	R19ME557 Product Life Cycle Management	R19ME567 Renewable Powered of Highway Vehicles	R19ME577 Haptics and Immersive Technologies
R19ME518 Digital Twin and Industry 5.0	R19ME528 Advanced Driver Assistance Systems	R19ME538 Tool Design	R19ME548 Computer Aided Inspection and Testing	R19ME558 Process Planning and Cost Estimation	R19ME568 Thermal Management of Batteries and Fuel Cells	R19ME578 Advanced Statistics and Data Analytics

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7.4 Professional Elective Courses with Credits:

Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
Vertical 1— Robotics and Automation								
1	R19ME511	Sensors and Instrumentation	PE	3	0	0	3	3
2	R19ME512	Electrical Drives and Actuators	PE	3	0	0	3	3
3	R19ME513	Embedded Systems and Programming	PE	3	0	0	3	3
4	R19ME514	Collaborative Robotics	PE	3	0	0	3	3
5	R19ME515	Robot Kinematics and Dynamics	PE	3	0	0	3	3
6	R19ME516	Drone Technologies	PE	3	0	0	3	3
7	R19ME517	Industry 4.0	PE	3	0	0	3	3
8	R19ME518	Digital Twin and Industry 5.0	PE	3	0	0	3	3
Vertical 2— Smart Mobility Systems								
1	**R19ME521**	Automobile Engineering	PE	3	0	0	3	3
2	**R19ME522**	Electric and Hybrid Vehicles	PE	3	0	0	3	3
3	**R19ME523**	Automotive Electronics	PE	3	0	0	3	3
4	**R19ME524**	Automotive System Modelling and Simulation	PE	3	0	0	3	3
5	**R19ME525**	Vehicle Styling and Design	PE	3	0	0	3	3
6	**R19ME526**	Aircraft Mechatronics	PE	3	0	0	3	3
7	**R19ME527**	Smart Mobility and Intelligent Vehicles	PE	3	0	0	3	3
8	**R19ME528**	Advanced Driver Assistance Systems	PE	3	0	0	3	3
Vertical 3— Design and Manufacturing								
1	**R19ME531**	Robot and Machine Elements Design	PE	3	0	0	3	3
2	**R19ME532**	Computer Aided Design and Manufacturing	PE	3	0	0	3	3
3	**R19ME533**	Design Concepts in Engineering	PE	3	0	0	3	3
4	**R19ME534**	Non-traditional Machining Processes	PE	3	0	0	3	3
5	**R19ME535**	Rotating Machinery Design	PE	3	0	0	3	3
6	**R19ME536**	Precision Manufacturing	PE	3	0	0	3	3
7	**R19ME537**	Failure Analysis and NDT Techniques	PE	3	0	0	3	3

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				L	T	P		
8	**R19ME538**	Tool Design	PE	3	0	0	3	3
Vertical 4— Digital and Green Manufacturing								
1	**R19ME541**	Digital Manufacturing and IoT	PE	3	0	0	3	3
2	**R19ME542**	Robots and Systems in Smart Manufacturing	PE	3	0	0	3	3
3	**R19ME543**	Industrial Robotics and Expert Systems	PE	3	0	0	3	3
4	**R19ME544**	Green Manufacturing Design and Practices	PE	3	0	0	3	3
5	**R19ME545**	Environment Sustainability and Impact Assessment	PE	3	0	0	3	3
6	**R19ME546**	Lean Manufacturing	PE	3	0	0	3	3
7	**R19ME547**	Green Supply Chain Management	PE	3	0	0	3	3
8	**R19ME548**	Computer Aided Inspection and Testing	PE	3	0	0	3	3
Vertical 5— Product and Process Development								
1	**R19ME551**	Product Design and Development	PE	3	0	0	3	3
2	**R19ME552**	Robotic Process Automation	PE	3	0	0	3	3
3	**R19ME553**	Additive Manufacturing	PE	3	0	0	3	3
4	**R19ME554**	Total Quality Management	PE	3	0	0	3	3
5	**R19ME555**	Design for Manufacturing and Assembly	PE	3	0	0	3	3
6	**R19ME556**	Advanced Manufacturing Systems	PE	3	0	0	3	3
7	**R19ME557**	Product Life Cycle Management	PE	3	0	0	3	3
8	**R19ME558**	Process Planning and Cost Estimation	PE	3	0	0	3	3
Vertical 6— Green Energy Technologies								
1	**R19ME561**	Renewable Energy Technologies	PE	3	0	0	3	3
2	**R19ME562**	Energy Conservation in Industries	PE	3	0	0	3	3
3	**R19ME563**	Energy Storage Devices	PE	3	0	0	3	3
4	**R19ME564**	Equipment for Pollution Control	PE	3	0	0	3	3
5	**R19ME565**	Energy Efficient Buildings	PE	3	0	0	3	3
6	**R19ME566**	Bioenergy Conversion Technologies	PE	3	0	0	3	3

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Sl. No.	Course Code	Course Name	Cate-gory	Periods/ Week			Total Contact Periods	Cre-dits
				L	T	P		
7	**R19ME567**	Renewable Powered off Highway Vehicles	PE	3	0	0	3	3
8	**R19ME568**	Thermal Management of Batteries and Fuel Cells	PE	3	0	0	3	3
Vertical 7— Artificial Intelligence and Machine Learning								
1	**R19ME571**	Generative AI for Engineering Design	PE	3	0	0	3	3
2	**R19ME572**	Machine Diagnostics and Condition Monitoring	PE	3	0	0	3	3
3	**R19ME573**	Exploratory Data Analysis and Visualization	PE	3	0	0	3	3
4	**R19ME574**	IoT Systems Design	PE	3	0	0	3	3
5	**R19ME575**	Microsystems Design and Applications	PE	3	0	0	3	3
6	**R19ME576**	Machine Vision	PE	3	0	0	3	3
7	**R19ME577**	Haptics and Immersive Technologies	PE	3	0	0	3	3
8	**R19ME578**	Advanced Statistics and Data Analytics	PE	3	0	0	3	3

7.5 Open Electives Courses (OEs):

Sl. No.	Course Code	Course Name	Cate-gory	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
1	R19AD651	Data Science Essentials	OE	2	0	2	4	3
2	R19AD652	Exploratory Data Analysis and Visualization	OE	2	0	2	4	3
3	R19AD653	Machine Learning Techniques	OE	3	0	0	3	3
4	R19AD654	Foundations of Artificial Intelligence	OE	3	0	0	3	3
5	R19CC651	Network Protocols	OE	2	0	2	4	3
6	R19CC601	High Speed Networks	OE	3	0	0	3	3
7	R19CC602	Introduction to Industrial Networking	OE	3	0	0	3	3
8	R19CC603	Basics of Mobile Communication	OE	3	0	0	3	3
9	R19CC604	Introduction to Wireless Communication Networks	OE	3	0	0	3	3
10	R19CB601	Algorithmic Trading Strategies	OE	3	0	0	3	3
11	R19CB602	Business Simulation	OE	3	0	0	3	3
12	R19CB603	Principles of Taxation	OE	3	0	0	3	3
13	R19CB604	Strategic Business Leader	OE	3	0	0	3	3

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Sl. No.	Course Code	Course Name	Cate-gory	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
14	R19CB605	Information Systems Control and Audit	OE	3	0	0	3	3
15	R19CS651	Application Development using Java	OE	2	0	2	4	3
16	R19CS652	Database Technologies	OE	2	0	2	4	3
17	R19CS653	Full Stack Technologies	OE	2	0	2	4	3
18	R19CS654	Fundamentals of Python Programming	OE	2	0	2	4	3
19	R19CS655	Competitive Coding Techniques	OE	2	0	2	4	3
20	R19AM601	Deep Learning Models	OE	3	0	0	3	3
21	R19AM602	Video and Speech Analytics	OE	3	0	0	3	3
22	R19AM603	Industrial Machine Learning	OE	3	0	0	3	3
23	R19AM604	Machine Learning for Smart Cities	OE	3	0	0	3	3
24	R19EC601	Discrete Time Signal Processing	OE	3	0	0	3	3
25	R19EC602	Principles of Analog and Digital Communication	OE	3	0	0	3	3
26	R19EC603	Digital Systems and VLSI Design	OE	3	0	0	3	3
27	R19EC604	Introduction to IoT	OE	3	0	0	3	3
28	R19EC605	Basics of Biomedical Instrumentation	OE	3	0	0	3	3
29	R19EC606	Introduction to Image processing	OE	3	0	0	3	3
30	R19EC607	Microcontroller and Embedded Systems	OE	3	0	0	3	3
31	R19EC608	Introduction to Wireless Sensor Networks	OE	3	0	0	3	3
32	R19EC609	Introduction to Robotics and Automation	OE	3	0	0	3	3
33	R19EC610	Medical Electronics	OE	3	0	0	3	3
34	R19EE601	Solid State Electronics	OE	3	0	0	3	3
35	R19EE602	Non Conventional Energy Sources	OE	3	0	0	3	3
36	R19EE603	Energy Conservation Practices	OE	3	0	0	3	3
37	R19EE604	Energy Auditing and Management	OE	3	0	0	3	3
38	R19EE605	Introduction to Hybrid and Electric Vehicles	OE	3	0	0	3	3
39	R19EE606	Design of Solar Photovoltaic Systems	OE	3	0	0	3	3
40	R19EE607	PLC and SCADA	OE	3	0	0	3	3
41	R19IT601	Introduction to Software Engineering	OE	3	0	0	3	3
42	R19IT602	Web Programming	OE	3	0	0	3	3
43	R19IT603	Basic of Software Testing	OE	3	0	0	3	3

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Sl. No.	Course Code	Course Name	Category	Periods/ Week			Total Contact Periods	Credits
				L	T	P		
44	R19IT604	Introduction to Block Chain Technology	OE	3	0	0	3	3
45	R19IT605	Soft Computing Technologies	OE	3	0	0	3	3
46	R19IT606	Fundamentals of IT Infrastructure Management	OE	3	0	0	3	3
47	R19IT607	Mobile Application Development	OE	3	0	0	3	3
48	R19IT651	Basics of Cloud Technology	OE	2	0	2	4	3
49	R19IT652	Introduction to Computer Networks	OE	2	0	2	4	3
50	R19IT653	Game Programming Fundamentals	OE	2	0	2	4	3
51	R19ME601	Product Design and Innovation	OE	3	0	0	3	3
52	R19ME602	3D Printing and Tooling	OE	3	0	0	3	3
53	R19ME603	Quality Management	OE	3	0	0	3	3
54	R19ME604	Enterprise Resource Planning	OE	3	0	0	3	3
55	R19ME605	Micro Electro Mechanical Systems	OE	3	0	0	3	3
56	R19ME606	Quality Control Tools and Techniques	OE	3	0	0	3	3
57	R19ME607	World Class Manufacturing	OE	3	0	0	3	3
58	R19ME608	Industrial Safety Engineering	OE	3	0	0	3	3
59	R19ME609	Introduction to Industry 4.0	OE	3	0	0	3	3
60	R19ME610	Lean Six Sigma and Supply Chain Management	OE	3	0	0	3	3
61	R19ME611	Business Organization and Development	OE	3	0	0	3	3
62	R19ME612	Product Distribution and Promotion Management	OE	3	0	0	3	3
63	R19ME613	Business Ethics, Corporate Social Responsibilities and Governance	OE	3	0	0	3	3
64	R19PH601	Laser Technology	OE	3	0	0	3	3
65	R19PH602	Nano Materials and Applications	OE	3	0	0	3	3
66	R19PH603	Physics for Solar PV System	OE	3	0	0	3	3
67	R19PH604	Medical Physics	OE	3	0	0	3	3
68	R19CY601	Chemical Sensors and Biosensors	OE	3	0	0	3	3
69	R19CY602	Energy Storing Devices	OE	3	0	0	3	3
70	R19CY603	Chemistry Forensic Science	OE	3	0	0	3	3
71	R19CY604	Industrial and Material Chemistry	OE	3	0	0	3	3
72	R19HS601	English for Competitive Examinations	OE	3	0	0	3	3
73	R19HS602	Personality Development and Interpersonal Skills	OE	3	0	0	3	3
74	R19HS603	Communication Techniques for Employability	OE	3	0	0	3	3
75	R19HS604	Mass Communication	OE	3	0	0	3	3

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8.0. B.E (Mech.) SYLLABUS

SEMESTER I

R19MA101	Matrix Algebra and Calculus	L	T	P	C
		3	1	0	4

1. Course Description:

Matrix algebra and calculus are fundamental mathematical subjects that find widespread applications in various fields, including physics, engineering, computer science, economics and more. Differential calculus emphasizes the understanding of rate of changes and integration spreads its wings in finding areas under curves, volumes of solids of revolution, and applications in engineering. The course enhances critical thinking and analytical skills.

2. Course Objectives:

1. Explore matrix techniques and its applications.
2. Enhance thier knowledge in infinite series and their convergence.
3. Familiarize the student with functions of several variables and its extremum.
4. Cultivate knowledge in double integration.
5. Inculcate the knowledge of triple integrals and their applications.

3. Syllabus

Unit-I: Matrices

Eigen values and eigen vectors:Eigen values and eigen vectors of a real matrix;Properties ;Cayley Hamilton theorem (statement only); Orthogonal transformation: Orthogonal transformation of a symmetric matrix to diagonal form, reduction of quadratic form to canonical form by orthogonal transformation.

Unit-II: Sequences and Series

Sequences: Definition and examples; Series: Types and convergence, series of positive terms; Tests of convergence: Comparison test, integral test and D'Alembert's ratio test; Alternating series: Leibnitz's test,Series of positive and negative terms, absolute and conditional convergence.

Unit-III: Multivariable Calculus

Functions of several variables: Partial derivatives,total derivative,differentiation of implicit functions, Jacobian,properties of Jacobians,Taylor's series, maxima and minima of functions of two variables, Lagrange's method of undetermined multipliers.

Unit-IV: Double Integration

Double integrals: Evaluation of double integrals, change of order of integration,double integrals in polar coordinates,area enclosed by plane curves.

Unit-V: Integration and its Application

Triple integrals: Evaluation of triple integrals, Volume as triple integral: simple problems, volume of solid, Gamma and Beta functions.

Text Books:

1. Grewal. B. S, "Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2015.

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2. Erwin Kreyszig, "Advanced Modern Engineering Mathematics", 10^{th} Edition, John Wiley and Sons (Asia) Ltd, Singapore, 2017.
References:
Reference Books:
1. H. K. Dass, "Advanced Engineering Mathematics", S. Chand & Company LTD, New Delhi, Reprint 2009. 2. John Bird, "Higher Engineering Mathematics", An imprint of Elsevier, Burlington, Reprint 2010. 3. Bali. N. P and Manish Goyal, "A Text book of Engineering Mathematics", 8^{th} Edition, Laxmi publications Ltd, 2011. 4. Veerarajan. T, "Engineering Mathematics", 3^{rd} edition, Tata Mc Graw Hill Education Pvt. Ltd, New Delhi, 2011.
Journals:
1. International Journal of Applied Mathematics: https://www.diogenes.bg/ijam/ 2. An International Journal for Theory and Applications: https://link.springer.com/journal/13540
Web Resources:
1. https://www.simplilearn.com/introduction-to-derivatives-rrt3co36vd364-video 2. https://www.khanacademy.org/math/calculus-home/integration-techniques-calc/trigonometric-substitution-calc/v/integrals-trig-substitution-1 3. http://www.dnatube.com/video/11238/What-Are-Conic-Sections 4. https://www.youtube.com/watch?v=AjmWR4kRtVk
MOOC/NPTEL/SWAYAM Courses:
1. nptel.ac.in/courses/111104092/ 2. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Mathematics%20I/TOC-middle-M14.html

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MA101.1	Determine inverse, higher integral powers by Cayley Hamilton theorem and convert quadratic form to canonical form by orthogonal transformation.
R19MA101.2	Test the convergence or divergence of series of positive terms and alternating series by various techniques.
R19MA101.3	Classify the extreme values of functions of two variables and functional dependence.
R19MA101.4	Apply integration concepts to compute area of the given surfaces, integrals in cartesian and polar coordinates.
R19MA101.5	Apply triple integration concepts to compute volume of the given surfaces and solid structure and area, volume of the surface using Gamma and Beta functions.

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R19CY101	Engineering Chemistry	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides the Bachelor of Engineering students a solid foundation in the concepts and applications of chemistry that are pertinent to engineering disciplines. The goal of this course is to provide students with the knowledge and abilities required for a variety of engineering specialties By fusing fundamental chemical principles with engineering applications, this course gives an insight to the engineering students for optimum utilization of resources in scientific, research, technological and industrial application.

2. Course Objectives:

1. To gain the abilities necessary to become an ideal engineer and to be flexible enough to adjust to new advancements in Engineering Chemistry.
2. Including the value of water for industrial use, the basic principles of battery chemistry, and the need to prevent corrosion in order to safeguard structures.
3. To study innovative methods and up-to-date chemical knowledge that inspires pupils to Communicate well and express themselves.
4. To gain the necessary understanding of engineering materials, such as glass, refractories, cement, and Nanomaterials.

3. Syllabus

Unit-I: Electrochemistry and Corrosion

Basics of electrochemistry; Electrochemical cell: Reversible and irreversible cell; EMF measurements; Standard Weston Cadmium cell; Nernst equation and problems; Electrodes: single electrode potential; Types of electrodes: Calomel electrode; Electrochemical series: Significance; Conductometric titration; Potentiometric titration.

Corrosion: Definition, Classification, mechanism; Factors influencing corrosion; Corrosion control: Sacrificial anode and cathodic protection method; Corrosion inhibitors; Electroplating of Nickel and chromium; Paints: Constituents and their function.

Unit-II: Water Technology

Introduction; Hardness of water: Determination of hardness of water by EDTA method; Alkalinity of water: Types of alkalinity, Estimation of alkalinity; Domestic water treatment: Pre-treatment, Removal of suspended impurities, Disinfection methods; Boiler feed water: Requirement of boiler feed water, Boiler troubles: scales and sludges; Treatment of boiler feed water: External treatment: Zeolite process, ion exchange method; Internal treatment method; Desalination: Reverse Osmosis.

Unit-III: Chemical Thermodynamics

Introduction to thermodynamics; Terminologies; Laws of Thermodynamics (only definitions): second law; Entropy as a thermodynamic quantity; Entropy change of an ideal gas: reversible and irreversible process, physical transformations; Clausius inequality theorem; Free energy and work function: Helmholtz and Gibbs free energy function, problems; Gibbs Helmholtz equation, problems; Clausius Clapeyron equation; Maxwell relation; Van't Hoff isotherm and its applications.

Unit-IV: Chemistry of Materials

Refractories; Classification, criteria of good refractory, properties and its application; Manufacture of Alumina, Magnesite and Silicon carbide.

Glass: Manufacture of glass by tank furnace method, Types and properties of glass.

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Cement: Portland cement; Comparison and Manufacture by rotary kiln technology; Chemistry of setting and hardening of cement; Role of gypsum.
Nanomaterials; Carbon nano tubes; shape memory alloys; C60 fullerene; Liquid crystals: properties and its application.

Unit-V: Polymer Technology

Introduction; Terminologies; molecular weight of polymers (only definition); Classification of polymers: natural and synthetic, thermoplastics and thermosetting plastics; Types and mechanism of polymerization: addition (free radical), condensation and copolymerization; Properties of polymers; some commercial thermosetting resin: Phenol formaldehyde resin, Amino resins, Silicone resins; some thermoplastics: Polyethylene, PVC, polyvinyl acetate.

Text Books:

1. R.Rathinam.,"Engineering Chemistry", Pearson India Pvt.Ltd,2nd edition,2019.
2. S.Vairam and Subha Ramesh .,"Engineering Chemistry", Wiley India, Delhi, 2015.
3. S P.C.Jain and M.Jain. "Engineering Chemistry", Dhanpat Rai Publishing Company, 16th Edition, New Delhi, 2017.
4. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.

References:

Reference Books:

1. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
2. J.C Kuriacase& J Raja ram. Engineering Chemistry. Tata McGraw Hills Co. New Delhi, 2004.
3. S.S. Dara and S.S. Umare., "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2014.
4. A. Pahari and B.Chauhan., "Engineering Chemistry", Laxmi Publications, 2nd Edition 2010
5. Devender Singh, Balraj Deshwal, Sathish Kumar.,"Comprehensive Engineering Chemistry", IK International, 2007.
6. H. K. Chopra, A. Parmer., "Chemistry for Engineers", Narosa Publishing House, 2016.

Web Resources:

1. https://onlinelibrary.wiley.com/journal/15272648
2. https://link.springer.com/journal/10800
3. https://benthamopen.com/TOTHERJ/home/
4 https://www.scimagojr.com/journalsearch.php?q=13540&tip=sid

Video References:

1. https://www.youtube.com/watch?v=l2ENx_Y0dNU
2 https://www.youtube.com/watch?v=hZIMFBuP8zc
3. https://www.youtube.com/watch?v=9GMBpZZtjXM
4. https://www.youtube.com/watch?v=x5OD2KZXd54
5. https://www.youtube.com/watch?v=k_RErdKwaAg

MOOC/SWAYAM/NPTEL Courses:

1. https://nptel.ac.in/courses/113104059/lecture_pdf/Lecture%209.pdf
2. https://nptel.ac.in/courses/Webcourse-contents/IIT-

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KANPUR/wasteWater/Domestic%20Water%20TS.htm 3. https://onlinecourses.swayam2.ac.in/nou24_es03/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY101.1	Apply the principles of electrochemistry and corrosion in engineering.
R19CY101.2	Understand the quality of water, and its treatment methods.
R19CY101.3	Apply the concepts relevant to thermodynamics.
R19CY101.4	Understand the Engineering materials.
R19CY101.5	Understand the science of polymer and polymer reactions.

R19CS101	Problem Solving Using C	L	T	P	C
		3	0	0	3

1. Course Description:

This course introduces students to the fundamental concepts of programming using the C language. The course covers essential topics such as basic C programming constructs, conditional and looping statements, modular programming, and advanced concepts like pointers, arrays, and structures. Through theoretical lectures, practical demonstrations, and coding exercises, students will develop problem-solving skills and learn how to design and implement efficient algorithms to solve a variety of complex problems.

2. Course Objectives:

1. Equip students with the skills to write robust, readable, and maintainable code for diverse applications.
2. Instruct students on utilizing control structures and functions to manage program flow, make informed decisions, and automate repetitive tasks.
3. Enhance students' abilities in optimizing memory usage and promoting code reusability.
4. Guide students in efficiently organizing and processing data, enabling them to write clean, well-structured code that addresses real-world challenges.
5. Train the students in effectively working with strings, user-defined data types, and file operations.

3. Syllabus:

Unit-I: C Fundamentals

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Basic computer organization, Problem-solving techniques, Algorithm, Flowchart, Pseudocode; Introduction to C programming: Phases of a C program, Features of C, Keywords, Variable Name, Scope, Declaration, Coding Standards, Data Types and sizes: integer, float and character types, constants, Formatted I/O, Operators, Bitwise Manipulations, Expression Evaluation, Type Conversions, Preprocessor Directives
Unit-II: Control Structures
Conditional and Branching Statements: if, if-else, else-if ladder, nested-if, switch constructs, range using switch, Looping constructs: for, while, do-while -break and continue- goto and Label
Unit-III: Pointers and Functions
Pointer - Types of Pointers: NULL, Dangling, Generic Pointers, Wild pointer, Arithmetic Operations in Pointer, Pointer to pointer, Functions: The anatomy of a function, Types of functions, Pointers and Function Arguments: Call by Value and Call by Reference, Function Pointers, return statement, Recursion, Storage Classes
Unit-IV: Arrays
Arrays: Declaring and initializing 1D arrays, Two-dimensional arrays, Multi-dimensional arrays, Variable Length Arrays, Dynamic Memory Allocation, Passing 1D and 2D Array as arguments, Pointers and Arrays, Array of pointers
Unit-V: Strings, User-Defined Data Types and Files
Strings: Introduction – string handling functions, Two-dimensional array of strings, Structure: Basics of structure- Nested structures–Array of structures – Pointer to structures – Unions - Bit Fields-Files: Basics– File Functions - Random Access Files
Text Books:
1. Herbert Schildt, "C – The Complete Reference", Tata McGraw Hill Publishing Company, New Delhi, 2017. 2. Kernighan B. W. and Ritchie D. M., "C Programming Language (ANSI C)", Prentice Hall of India Private Limited, New Delhi, 2010.
References: **Reference Books:** 1. Deitel and Deitel, "C How to Program", Pearson Education, New Delhi, 2011. 2. Simple Program Design: A Step-by-Step Approach, Fifth Edition by Lesley Anne Robertson **Video References:** 1. https://www.youtube.com/watch?v=EjavYOFoJJ0&list=PLdo5W4Nhv31a8UcMN9-35ghv8qyFWD9_S 2. https://www.youtube.com/watch?v=irqbmMNs2Bo **MOOC/NPTEL /SWAYAM Courses:** 1. https://onlinecourses.nptel.ac.in/noc22_cs40/preview 2. https://onlinecourses.nptel.ac.in/noc23_cs53/preview

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS101.1	Understand problem-solving techniques and typical programming constructs C
R19CS101.2	Apply looping and conditional constructs to solve real-world problems
R19CS101.3	Apply arrays and functions effectively to address complex programming challenges
R19CS101.4	Understand and apply best practices in pointers, memory allocation and error handling for modular programming efficiency
R19CS101.5	Choose and implement complex data structures using structures and Unions, applying advanced file operations in C for effective problem-solving

R19ME101	**Engineering Graphics**	**L**	**T**	**P**	**C**
		1	**0**	**4**	**3**

1. Course Description:

This course provides a comprehensive introduction to engineering drawing techniques, emphasizing fundamental principles such as orthographic projection, dimensioning, and geometric construction. Students will learn to create accurate and detailed engineering drawings manually and using Computer-Aided Design (CAD) software. Through practical exercises, students will develop proficiency in visual communication and problem-solving skills essential for engineering design and drafting. This course will also cover industry standards and conventions, ensuring students are prepared for professional practice.

2. Course Objectives:

1. Develop proficiency in fundamental drawing techniques, including line work, dimensioning, and geometric construction, to accurately represent engineering designs on paper and digitally.
2. Understand and apply orthographic projection methods to generate multiple views (e.g., plan, elevation, section) of engineering objects, ensuring clear and precise communication of design intent.
3. Learn to create isometric projections to represent three-dimensional objects with equal foreshortening along each axis, facilitating visualization and understanding.
4. Gain an introduction to perspective projection techniques to accurately depict depth and spatial relationships in engineering drawings.

3. Syllabus

Unit-I: Free Hand Sketching and Curves

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Introduction Importance of graphics in engineering applications; Use of drafting instruments; BIS conventions and Specifications: Size, layout, folding of drawing sheets, Lettering, dimensioning. (Not for Examination) Free Hand sketching; Visualization principles; Representation of Three-Dimensional objects; Layout of views; Application of free hand sketching. **Curves** Conics: Construction of ellipse, parabola and hyperbola by eccentricity method; Construction of cycloid; construction of involutes of square and circle; Applications: Engineering Curves Computer Aided Drafting (Hands on training, not for Examination) Study the basics of 2D and 3D modelling; Lettering, title block drafting; DWG file development using any CAD software.
Unit-II: Projection of Points, Lines and Surfaces
Projection: Points, Straight lines located in first quadrant using rotating line method; Traces; Projection of plane surfaces: polygonal lamina, circular lamina; Applications: Projection of points, lines, surfaces. Computer Aided Drafting (Hands on practice, not for Examination) Drafting of simple geometrics: Line, planes, simple 2D drawings.
Unit-III: Projection of Solids
Projections of simple solids: Prism, Pyramid, Cylinder and Cone; Drawing views when the axis of the solid is inclined to one reference plane by rotating object method; Applications: Projection of solids.
Unit-IV: Sections and Development
Section of simple solids: Simple vertical position, when the cutting plane is inclined to the one of the principal planes, perpendicular to the other; Obtaining true shape of section; Development of lateral surfaces: Truncated prisms, pyramids, cylinders, cones; Applications: sections of solids, development of lateral surfaces.
Unit-V: Isometric and Perspective Projection
Principles of isometric projection; isometric scale; Isometric projections (Simple, Truncated): Prisms, pyramids, cylinders, cones, combination of two solid objects in simple vertical positions; Perspective projection (Visual ray method): Prisms, pyramids, cylinders, cone; Applications: Isometric projection, perspective projection. Computer Aided Drafting (Hands on practice, not for Examination) Introduction to computer aided drafting, dimensioning using appropriate software; 2D drawing commands: Zoom, Picture editing commands, Dimensioning, Isometric drawing, Isoplanes, 3D drafting; Plotting of drawing; Practice: Projection of lines, planes, solids; Isometric view practice: prisms, pyramids, cylinders and cones.
Text Books:
1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai,2019

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2. Venugopal K. And PrabhuRaja V., "Engineering Graphics", New Age International (P) Limited,2019

Reference Books:

1. Bhatt N.D, "Machine Drawing", Charotar Publishing House, 1st Edition, 2010.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, 1st Edition, 2008.
3. Gopalakrishna K.R., "Machine Drawing in first angle projection, Subhas Stores, Bangalore, 1st Edition, 2007.
4. K Leo Dev Wins., "Engineering Drawing", Pearson (Wins) Publications, Latest Edition, 2019.
5. Luzzader, Warren.J. and Duff,John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
6. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to End Semester Examinations on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME101.1	Perform freehand sketching of geometrical constructions representing multiple views of objects to enhance visualization and communication skills.
R19ME101.2	Prepare orthographic views using projection methods, and interpret technical drawings for engineering communication.
R19ME101.3	Draw the projection of solids ensuing accurate representation and visualization of 3D objects in engineering drawings.
R19ME101.4	Develop and interpret the sectional views of the solids in a given cutting plane.
R19ME101.5	Prepare isometric view and evaluate the perspective projection for the given solids.

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R19ME102	Engineering Mechanics	L	T	P	C
		3	1	0	4

1. Course Description

Engineering Mechanics is a foundational course designed to introduce students to the principles governing the equilibrium and motion of bodies under the influence of forces. The course encompasses statics and dynamics, laying the groundwork for further studies in various engineering disciplines. Topics covered include vector analysis, force systems, equilibrium, friction, kinematics, dynamics, energy, and the application of these principles to analyze and solve engineering problems. Moreover, this course providing knowledge to students in the analytical tools and problem-solving skills necessary for success in more advanced engineering courses and in professional engineering practice.

2. Course Objectives:

1. To learn the action forces, reaction forces and resultant forces in static bodies through scalar and vector approach.
2. To solve the moments and couples for the different kinds of loads and supports in statically determinate structure by scalar and vector approach.
3. To study and determine the properties of surfaces and solids.
4. To learn about the fundamentals of friction concepts, dynamics of forces in rigid body

3. Syllabus

Unit-I: Statics of Particles

Introduction to Mechanics: Units and Dimensions, Laws of Mechanics, Lami's theorem, Parallelogram and Triangular Law of forces; Vectorial representation of forces: Additions, Subtraction, Dot product, Cross product; System of forces: Coplanar forces, Forces in space, Rectangular components; Equilibrium of a particle: Equilibrium of a particle in space, Equivalent systems of forces, Principle of transmissibility.

Computer Aided Simulation (Hands on practice, not for Examination)

Newton's three laws, identify the common forces working on a given object in a given situation, finding the net force acting on an object and identify how it will affect the object.

Unit-II: Equilibrium of Rigid Bodies

Equilibrium of Rigid bodies in two dimensions: Free body diagram, Types of supports, Action and reaction forces, Single equivalent force, Stable equilibrium; Moments and Couples: Moment of a force about a point and about an axis, Varignon's theorem, Scalar components of a moment; Vectorial representation of moments and couples: Equilibrium of Rigid bodies in three dimensions.

Computer Aided Simulation (Hands on practice, not for Examination)

Modeling center of gravity, moment of force and lever arm.

Unit-III: Properties of Surfaces and Solids

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Centroids and centre of mass; Centroids of lines and areas: Rectangular, circular, triangular areas by integration; T section, I section, Angle section, Hollow section by using standard formula; Theorems of Pappus; Area moments of inertia of plane areas: Rectangular, circular, triangular areas by integration; T section, I section, Angle section, Hollow section by using standard formula; Parallel axis theorem and perpendicular axis theorem; Principal moments of inertia of plane areas; Principal axes of inertia; Mass moment of inertia; mass moment of inertia: prismatic, cylindrical and spherical solids from first principle; Relation to area moments of inertia.

Computer Aided Simulation (Hands on practice, not for Examination)

Methods of finding centre of gravity of an irregular body, Model a situation for centre of gravity and create an interactive simulation.

Unit-IV: Dynamics of Particles

Relationships: Displacements, Velocity and acceleration; Relative motion; Rectilinear Motion; Curvilinear motion; Newton's laws of motion; Kinetics of Particles: D'Alembert's principle, Work Energy Equation, Impulse and Momentum Principle.

Computer Aided Simulation (Hands on practice, not for Examination)

Falling under the influence of gravitational acceleration only; Air drag: Influence of air drag of a falling object.

Unit-V: Friction and Fundamentals of Robotics

Introduction: Frictional force, Mechanism of friction, Laws of Coulomb friction; Types of friction: Simple contact friction, Ladder friction, Wedge Friction, Belt friction, Screw Jack, Rolling resistance.

Robotics: Law of robotics, Anatomy, Configuration of robots, Types of robots; Free body diagram of robot configuration and force analysis.

Computer Aided Simulation (Hands on practice, not for Examination)

Robot programming and simulation for pick and place / machining (cutting, welding); Simple 6-DOF Robot Manipulator Simulation System

Text Books:

1. Beer, F.P and Johnson, E.R, Vector Mechanics for Engineers, Statics and Dynamics, 11th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2017.
2. Kottiswaran, N, Engineering Mechanics-Statics and Dynamics, 5th edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2017.

Reference Books:

1. Bansal, R.K, Engineering Mechanics, 2nd edition, Laxmi Publications Pvt. Ltd., New Delhi, 2009.
2. Young, D.H and Timashenko, S, Engineering MechanicsI, 4th edition, McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
3. JivanKhachane, RuchiShrivastava, Engineering Mechanics: Statics and Dynamics, 1st edition, ANE Books, 2006.
4. Irving, H. Shames, G, Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, 4th edition, Pearson Education Asia Pvt. Ltd., 2014.
5. Arthur P. Boresi, Richard J. Schmidt, Engineering Mechanics Statics and Dynamics, 1st edition, Cengage Learning, 2008.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME102.1	Solve the scalar and vector representation of forces and analyze the behavior of particles in equilibrium conditions
R19ME102.2	Solve the scalar and vector representation of forces and moments and analyze the behavior of rigid bodies in equilibrium conditions.
R19ME102.3	Analyze the properties of surfaces and solids.
R19ME102.4	Calculate dynamic forces exerted in particles.
R19ME102.5	Determine the frictional force & its effects by using laws of friction and understand the fundamentals of force analysis in robots.

R19HS151	**Technical English**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

1. Course Description:

This course aims to educate the first year BE/B.Tech students in basic principles of English language, facilitate them to use vocabulary in different academic and professional contexts. It also cultivates their LSRW skills, namely listening, speaking, reading and writing skills thereby improving their proficiency in oral and written communication in technical English. It also covers all the areas of grammar, word formation, summarizing, report writing, which are necessary for the students of engineering sciences.

2. Course Objectives:

1. Enable learners of Engineering and Technology to develop their basic communication skills in English.
2. Emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
3. Ensure that learners use the electronic media such as internet and supplement the learning materials used in the class room.
4. Inculcate the habit of reading and writing leading to effective and efficient communication.

3. Syllabus:

Unit-I: Basic Language Development

Reading: Types of Reading, Skimming and Scanning, Reading Comprehension
Writing: Word Formation, Sequence Words, Types of Sentences, Hints Development, Informal Letters—Congratulating, apologizing, etc
Grammar: Parts of Speech, Articles, Tenses.

Unit-II: Different Strategies of Reading

Reading: Articles from Newspapers & Magazines, Cloze Exercises
Writing: Instructions, Recommendations, Paragraph Writing
Grammar: Homonyms, Homophones, Homographs, Subject – Verb Agreement, Modal Verbs, Question Types, Wh-type, Yes/ No and Tag Questions.

Unit-III: Group Interaction

Reading: Reading for Specific Information & Identifying Lexical and Contextual Meaning

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Writing: Formal Letters—Seeking Permission for Industrial Visit, Letter of Invitation (acceptance/declination), Jumbled Sentences Grammar: Cause and Effect Expressions, Purpose & Function, Compound Nouns.
Unit-IV: Introduction to Effective Writing
Reading: Summarizing, Paraphrasing, Note Making Writing: Business Letters (Enquiry, Calling for Quotations & Placing Orders), Email-Etiquette, Writing Emails, Free Writing on any given topic Grammar: Phrasal Verbs, Single Sentence Definitions.
Unit-V: Technical Writing Practice
Reading: Reading Practice based on Competitive Examinations Writing: Preparing Transcript for a Speech, Pictorial Representation (Charts —Flowcharts, Pie Charts, Bar Charts, Tabular Column, etc) Grammar: Single Word Substitute, Abbreviations & Acronyms, Spotting Errors.
List of Exercises: 1. Listening - Listening Types - Listening to Audio files and answering 2. Listening - Listening for specific information – Listening to announcements and Radio Broadcasts 3. Listening - Listening to TED Talks & News Reading from English News Channels (CNN, NDTV, India 4. Today etc.) 5. Listening - Listening Comprehension and answering accordingly. 6. Listening - Listening to Eminent personality interviews & other forms of interviews 7. Speaking - Introducing oneself & family - Role Play 8. Speaking – Extempore - Just A Minute (JAM) Sessions 9. Speaking - Group Discussion 10. Speaking - Narrating a story 11. Speaking – Compering, Welcome Address & Vote of Thanks
Text Books:
1. Jack C. Richards, "Interchange Student's Book 1", Cambridge University Press; Fourth Edition, 2015. 2. 2. S. N. Mahalakshmi, "Technical English for Engineers", V. K. Publications; Chennai, Eighth Edition, 2020.
References:
Reference Books: 1. Rizvi M.Ashraf, "Effective Technical Communication", Tata McGraw Hill Publishing Company; New Delhi, 2015. 2. Andrea J.Rutherford, "Pearson Education" Inc. and The Darling Kindersley Publishing Inc., 2020. 3. Raman, Meenakshi and Sharma, Sangeetha "Technical Communication Principles and Practice", 4. Oxford University Press; New Delhi, 2019. 4. Richards C. Jack, "Interchange", Fourth edition; Cambridge University Press, 2020. 5. Butterfield, Jeff, "Soft skills for Everyone", Sixth Indian Reprint, 2018. **Video References:** 1. https://www.youtube.com/watch?v=tBtc6rpcMz4 2. https://www.youtube.com/watch?v=Ll23cChDSKE 3. https://www.youtube.com/watch?v=fyAtyAdCStM **Web References:** 1. https://leo.stcloudstate.edu/grammar/subverag.html 2. http://www.learningdifferences.com/Main%20Page/Topics/Compound%20Word%20Lists/Compound_Word_%20Lists_complete.htm

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3. http://examples.yourdictionary.com/examples-of-active-and-passive-voice.html 4. http://www.perfectyourenglish.com/grammar/numeral-adjectives.htm 5. https://en.wikipedia.org/wiki/Commonly_misspelled_English_words 6. https://www.englisch-hilfen.de/en/grammar/if.htm 7. http://www.englishforeveryone.org/Topics/Reading-Comprehension.htm **MOOC/SWAYAM/NPTEL Courses:** 1. https://www.udemy.com/topic/communication-skills/free/ 2. https://www.bbc.co.uk/learningenglish/english/course/how-to-speak-english

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS151.1	Apply basic reading techniques, construct clear sentences for informal correspondence, and enhance grammar and listening skills for effective communication.
R19HS151.2	Analyze complex texts, formulate precise instructions and recommendations, and utilize advanced grammar in spoken communication.
R19HS151.3	Simplify specific and contextual information, compose formal letters, and actively engage in group discussions.
R19HS151.4	Interpret and take notes proficiently, compose professional documents and emails, and demonstrate strong listening skills.
R19HS151.5	Analyze and create detailed technical documents and visual aids, and deliver formal presentations and conduct interviews with confidence.

R19CY111	**Chemistry Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**
1. Course Description:					
Engineering students can gain practical experience and understanding of chemical principles necessary for engineering practice which will help them to get exposed to fundamental laboratory procedures, improve their comprehension of chemical topics to build their critical thinking and problem-solving abilities.					
2. Course Objectives:					

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1.	To equip engineering students with precise measurement techniques, safe chemical handling, proper equipment usage, and adherence to experimental protocols.
2.	Through hands-on experiments, reinforce theoretical concepts from lectures, providing practical insights into chemical phenomena, reactions, and properties.
3.	To develop critical thinking through engaging in experimental design, data analysis, and problem-solving to apply scientific reasoning, identify errors, and address challenges, fostering a stronger grasp of the scientific method.
4.	To cultivate teamwork by collaborating in group lab activities, enhancing communication, task delegation, and cooperation skills essential for success in engineering and beyond.
5.	To prioritize safety protocols and hazard awareness to instill a safety-oriented mindset, ensuring responsible conduct and risk mitigation during experiments.

3. Syllabus:

List of Experiments:

1. Determination of total, permanent and temporary hardness of water by EDTA method.
2. Estimation of copper in brass by EDTA method.
3. Determination of alkalinity and TDS of water sample.
4. Estimation of chloride content in water by Argentometric method.
5. Determination of strength of acid by Conductometric titration (strong acid Vs strong base & strong base vs mixture of acids).
6. Determination of strength of given hydrochloric acid using pH meter.
7. Estimation of ferrous ion content of the given solution using Potentiometer.
8. Determination of do content of water sample by Winkler's method.

Text Book:

1. 1. R.Rathinam.," Chemistry Lab Manual", Gems Publishers, 2019.

References:

1. Vogel's, "Text book of Quantitative Chemical Analysis", Pearson Publications, 2014.
2. Daniel C Harris, "Quantitative Chemical Analysis", W. H. Freeman and Company, New York, 7th Edition 2007.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY111.1	Analyse the role of water quality related parameters.
R19CY111.2	Design the engineering materials against corrosion.

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R19CY111.3	Competent in applying the Argentometric method to precisely determine the chloride content in water, as well as in data analysis, laboratory procedures, and safety protocol observation.
R19CY111.4	Execute conductometric titrations and implement your understanding about the estimation of the substance from the given sample through data interpretation.
R19CY111.5	Implement the electrochemical methods to measure the concentration and amount of unknown chemical substances by validating the data using calibration techniques essential for quantitative analysis.

R19GE111	**Engineering Practices Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

1. Course Description:

The Engineering Practices Laboratory provides hands-on experience and practical training for students to apply theoretical knowledge in engineering disciplines through experiments and projects. The course plays a crucial role in fostering practical skills, enhancing problem-solving abilities, and bridging the gap between theoretical learning and real-world engineering applications. The course equips engineers with practical skills, critical thinking abilities, and hands-on experience essential for tackling real-world challenges and succeeding in their future careers.

2. Course Objectives:

1. To provide exposure to the students with hands on experience on various basic engineering practices in Computer Science, Mechanical, Electrical and Electronics Engineering.
2. To enhance the problem-solving abilities of the students by bridging the gap between the theoretical learning and real-world engineering application.

3. Syllabus:

Group A (Computer Science & Mechanical)

Computer Science and Engineering Practices

Assembly & Disassembly :

1. Identifying components of disassembling and assembling the PC Troubleshooting
2. Basic H/W and S/W troubleshooting

Mechanical Engineering Practices

Plumbing:

1. Construction of pipeline using fittings: joints, gate valves, taps, reducers; examine the functions of the plumbing tools.
2. Develop plumbing connection of a residential building involving minor troubleshooting

Basic Machining:

1. Inspect the dimension of the given work piece after executing simple lathe operations

Rapid Prototyping:

1. Additive Manufacturing of 3D component without support structure

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2. Additive Manufacturing of 3D component with support structure **Study and assemble/ maintenance the following (Demonstration only):** 1. Different types of pumps, Dynamic: Centrifugal pump, Submersible pump; Positive Displacement: Reciprocating Pump 2. Experimental learning on basic connections with minor troubleshooting of Refrigeration System. 3. Experimental learning on basic connections with minor troubleshooting of Air-Conditioning System.
Group B (Electrical & Electronics)
Electrical Engineering Practices
a) UPS Connection - Hands on exercise on basic electrical connections with UPS Connection b) Domestic Wiring - Hands on exercise on basic domestic wiring c) Safety Precautions - Hands on exercise on electrical earthing and safety precautions d) Renewable Energy - Design of Solar PV System for Residence (Study)
Electronics Engineering Practices
a) Soldering - Study of Electronic Components & Equipment – Soldering Practice b) Electronics - Study of components of Smart phones c) Automation Projects - Projects on home automation

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19GE111.1	Perform the basic troubleshooting of the PC including assembly and disassembly.
R19GE111.2	Identify minor plumbing troubleshooting in residential buildings and develop 3D component by additive manufacturing
R19GE111.3	Inspect work piece after executing basic machining operations like turning, drilling & tapping and minor troubleshooting, maintenance task in an AC & pump/motor.
R19GE111.4	Perform basic domestic wiring of a residential building with provision of inverter and safety measures and Design solar PV System for residence.
R19GE111.5	Execute basic home automation projects.

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R19CS111	Problem Solving Using C Laboratory	L	T	P	C
		0	0	4	2

1. Course Description:

The Problem Solving Using C Laboratory is a practical course designed to complement theoretical knowledge with hands-on experience in programming using the C language. Through a series of laboratory sessions, students will delve into the basic concepts of C programming, including conditional and looping statements, modular programming, and advanced topics such as pointers, arrays, and structures. By actively engaging in coding exercises and projects, students will develop problem-solving skills, algorithmic thinking, and proficiency in implementing efficient solutions to various computational problems.

2. Course Objectives:

1. Instruct students on developing robust, readable, and maintainable code for a variety of applications.
2. Teach students to effectively use control structures and functions to manage program flow, make decisions, and automate repetitive tasks.
3. Enhance students' ability to optimize memory usage and promote code reusability in their programs.
4. Guide students in organizing and processing data efficiently, enabling them to write clean, structured code that addresses real-world problems.
5. Train students in working proficiently with strings, user-defined data types, and file operations.

3. List of Experiments:

1. Develop flow charts and solve simple real-life or scientific or technical problems (Traffic signal control / Water level controller / Temperature control system / Automatic washing machine control system / Automatic Street light control system / Electricity Billing / Retail shop billing /Computing Electrical Current in Three Phase AC circuits) (Minimum 3 problems) (CO1)
2. Implementation of applications of input and output statements. (Integer, char, Float, string input and output, ASCII value of character, User details) (CO1)
3. Implementation operators and expressions (Centigrade to Fahrenheit, Quotient and Remainder, Kilometres per hour to miles per hour, Hour and Minutes, Profit Calculator) (CO1)
4. Implementation of real-time applications using conditional statements. (Vowel or Consonant, Eligible for casting vote, Leap year or not, Display the description for the given grade, Display number of days in a month, Calculator, Triangle type, Roots of a quadratic equation) (CO1)
5. Implementation of technical applications using iterative loops (Display first N natural numbers, Read N numbers and find their sum and average, find cube of the number up to a given integer, Multiplication table, Sum of N natural numbers, Sum of N natural odd numbers, Pattern printing) (CO2)
6. Implementation of the one-dimensional array (Display the array elements, Elements in reverse order, Sum of array elements, make a copy of array elements, Maximum and minimum, odd sum and even sum) (CO2)
7. Implementation of a two-dimensional and multi-dimensional array (sum, subtraction, transpose, multiplication, frequency of even numbers, print diagonals, sum of diagonal elements, compare) (CO2)

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8. Implementation of Functions in the program (Factorial, largest number, area of shape, sum of digits, prime number or not) (CO2)
9. Implementation of real-time applications using recursion (factorial, Fibonacci series, count digits of number, length of string, prime or not, GCD, sum of all digits, palindrome) (CO2)
10. Implementation of a pointer in applications (swap two numbers, print string, read array elements, double pointer, find the maximum number, palindrome, reverse array, dynamic memory allocation) (CO3)
11. Implementation of strings handling functions with and without library functions (compare two strings, reverse, concatenate, copy, palindrome, count number of characters, number of words, find, replace) (CO4)
12. Implementation of file-handling operations (read, write, append file, compare two files, read student details and store into files) (CO4)
13. Implementations of Structure in real-time applications (Accept & display employee details, Calculate total payment of workers, Library operations, Menu-driven program for employee structure) (CO5)
14. Implementations of Union in programs (Accept & display employee details, Calculate total payment of workers, Library operations, Menu-driven program for employee structure) (CO5)
15. Mini Project: Develop an application for any real-world problem

Reference Books:

1. Herbert Schildt, "C – The Complete Reference", Tata McGraw Hill Publishing Company, New Delhi, 2017.
2. Kernighan B. W. and Ritchie D. M., "C Programming Language (ANSI C)", Prentice Hall of India Private Limited, New Delhi, 2010.
3. Deitel and Deitel, "C How to Program", Pearson Education, New Delhi, 2011.
4. Simple Program Design: A Step-by-Step Approach, Fifth Edition by Lesley Anne Robertson

Video References:

1. https://www.youtube.com/watch?v=EjavYOFoJJ0&list=PLdo5W4Nhv31a8UcMN9-35ghv8qyFWD9_S
2. https://www.youtube.com/watch?v=irqbmMNs2Bo

MOOC/NPTEL /SWAYAM Courses:

1. https://www.udemy.com/course/c-programming-2019-master-the-basics
2. https://www.tutorialspoint.com/cprogramming

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS111.1	Design solutions for real world problems with programming constructs
R19CS111.2	Solve complex programming problems with arrays and functions
R19CS111.3	Implement dynamic memory addressing techniques with Pointers
R19CS111.4	Implement various error handling techniques for file operations
R19CS111.5	Implement complex data structures such as structures and unions in C to manage and organize data effectively

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R19EM101	Soft Skills	L	T	P	C
		0	0	2	1

1. Course Description:

This course on Soft Skills is designed to enhance the professional development of engineering students by refining essential interpersonal and communication skills. It focuses on cultivating critical attributes such as effective communication, active listening, teamwork, leadership, and time management. The course also emphasizes the importance of professional etiquette, advanced communication techniques, technical writing, and the ability to navigate formal and informal contexts. By integrating these elements, students will develop the competencies necessary for successful collaboration, decision-making, and professional growth in the engineering field.

2. Course Objectives:

1. Develop foundational language skills by reinforcing key communication principles.
2. Instill positive behavioural traits to prepare students for future interactions in the corporate environment.
3. Equip students with the knowledge and skills needed to communicate ideas on social issues, promoting a sense of responsibility and active citizenship.
4. Enhance leadership abilities, teamwork strategies, and the capacity to foster effective connections through impactful communication.
5. Strengthen confidence and public speaking skills by offering experiential learning and techniques to overcome presentation anxiety and communicate effectively in front of an audience.

3. Syllabus:

Unit-I: PERSONALITY AND PROFESSIONAL DEVELOPMENT SKILLS

Interpersonal skills: communication skills, active listening, teamwork, empathy, leadership, motivation, social skills – effective body language – workplace etiquette – types of speeches: memorized speech, manuscript speech, impromptu, and extempore.

Unit-II: ADVANCED COMMUNICATION SKILLS

Word and sentence stress – clear individual sounds – intonation patterns – pronunciation – mother tongue intrusion – tongue twisters - conversation practice: discourse markers, slang, colloquial expressions, collocation - making mini presentations – extending on conservations – collaborative task.

Unit-III: EFFECTIVE COMMUNICATION SKILLS

Verbal and non-verbal communication - formal and informal English – grammatical features: impersonal passives, nominal compounds, third persons, empty verbs, present tense, imperatives, active voice, jargon, cliches – presentation skills - resume preparation - group discussions – mock interviews.

Unit-IV: TEAM SKILLS AND INTERPERSONAL COMMUNICATION

Personal skills: time management, motivating others, assessing alternatives and making decisions, accurate written work, organisational skills, attention to detail, negotiation and mediation skills – public speaking - panel discussion – debates

Unit-V: ENGINEERING JOURNALISM

Technical writing style: accuracy, conciseness, clarity, objectivity – abstract writing – technical documents writing - blogs - editing - copyrights - plagiarism

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References:

Reference Books:

1. Norman Lewis, "Word power made easy".2020.
2. Sylvia Reyes," Team Building: The Ultimate Guide to Build & Manage Winning Teams", MC Graw hill, 2014.
3. Dan Clay, how to write the perfect resume 2018.
4. Tyler Hayden," Communication Activities: A Team Building Activity Book", 2019.
5. Ian Tuhovsky, "Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, 2019.
6. Presentation, Persuasion and Public Speaking (Positive Psychology Coaching Series Book, 2015.

Jourals:

1. The IUP Journal of Soft Skills - https./iupindia.in/softskills.asp
2. Soft Skills Personality Development for Life Success https://reader.magzter.com/preview/4lf6by5blmhou4q0k43xgh4388150/438815

Video References:

1.https://youtube.com/playlist?list=PLLy_2iUCG87CQhELCytvXh0E_ybOO1_q&feature=shared

2.https://youtube.com/playlist?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ&feature=shared

3.https://m.youtube.com/watch?feature=shared&v=DUlsNJtg2L8

4.Course Outcomes:

After successful completion of the course, the student should be able to:

CO.No.	Course Outcome
R19EM101.1	Understand and apply interpersonal skills to enhance professional interactions and goal-setting.
R19EM101.2	Demonstrate clear and effective communication in reports and presentations to showcase professional skills.
R19EM101.3	Utilize advanced communication techniques to improve verbal and written effectiveness.
R19EM101.4	Analyze team dynamics and personal skills to enhance individual and group performance.
R19EM101.5	Create accurate and concise technical documents to uphold high standards in engineering journalism

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SEMESTER II

R19MA102	Advanced Calculus and Complex Variables	L	T	P	C
		3	1	0	4

1. Course Description:

Calculus and Complex variables is a foundational course that combines two important branches of mathematics which deals with the study of rates of change and accumulation, and complex variables, which extends the concepts of real numbers to the complex plane. This course provides students with a rigorous understanding of calculus principles and techniques including derivatives, integrals and applications as well as an introduction to complex numbers, functions, differentiation, and integration in the complex plane.

2. Course Objectives:

1. Impart an idea of vector calculus and its physical interpretation.
2. Facilitate knowledge in analytical functions and to construct the analytic functions.
3. Introduce complex analysis for addressing problems across diverse fields.
4. Enhance the knowledge of Laplace transform to solve linear mathematical models for a physical system.
5. Inculcate techniques in solving ordinary differential equations.

3. Syllabus

Unit-I: Vector Calculus

Gradient and directional derivative; Divergence and curl; Irrotational and solenoidal vector fields; Integral Theorems: Green's theorem in a plane, Gauss divergence theorem, Stoke's theorem (excluding proofs), Verification of theorem and applications (for cubes and rectangular parallelepipeds).

Unit-II: Complex Differentiation

Analytic functions: Cauchy-Riemann equations (excluding proof), Properties of analytic function, Harmonic conjugate; Construction of analytic function by Milne Thomson method, Bilinear transformation.

Unit-III: Complex Integration

Cauchy 's integral theorem, Cauchy 's integral formula, Cauchy 's integral formula for derivatives, Cauchy residue theorem; Taylor's and Laurent's series; Contour integral in unit circle and semi-circle (Excluding poles on real axis).

Unit-IV: Laplace Transforms

Existence conditions, Properties (excluding proofs), Transform of elementary and special functions, Transforms of derivatives and integrals; Periodic function; Inverse Laplace transform; Applications to solution of linear second order ordinary differential equations with constant coefficients.

Unit-V: Ordinary Differential Equations

Higher order linear differential equations with constant coefficients; Cauchy's and Legendre's linear differential equations; Method of variation of parameters; Application of ordinary differential equations in simple harmonic motion and basic elements of electrical circuits.

Text Books:

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R19PH101	Engineering Physics	L	T	P	C
		3	0	0	3

1. Course Description:

Engineering Physics is a fundamental course designed to provide mechanical engineering students with a strong foundation in the field of mechanical, thermal, magnetic, electrical properties of material, and also nanomaterials used in latest technologies which are very useful to the students in solving real time problems.

2. Course Objectives:

To enable the students to:

1. Perceive the basic concepts of physics and underlying applications relevant to engineering and technology.
2. Relate properties of Wave optics and Laser to solve relevant numerical problems.
3. Emphasize the classification of various types of magnetic and superconducting materials.
4. Extend the concept of nano materials and compare its properties with those of bulk materials.

3. Syllabus:

Unit-I: Properties of Matter

Elasticity: Hooke's law, Stress-strain diagram and its uses, factors affecting elastic modulus; Torsional stress and deformations: twisting couple, torsion pendulum, theory and experiment; Bending of beams: bending moment, cantilever: theory and experiment, Applications: I-shaped girders; Viscosity: coefficient of viscosity, Stoke's theorem, Bernoulli's theorem, Applications.

Unit-II: Laser And Fiber Optics

Lasers: population of energy levels, resonant cavity, optical amplification (qualitative), Einstein's A and Coefficients derivation; Semiconductor lasers: Homojunction and Hetrojunction.

Fiber optics: principle, numerical aperture and acceptance angle, types of optical fibres (material, refractive index, mode); losses associated with optical fibers;fibre optic sensors: pressure and displacement.

Unit-III: Thermal Physics

Transfer of heat energy: thermal expansion of solids and liquids, expansion joints , bimetallic strips ; thermal conduction, convection and radiation ; heat conduction in solids : thermal conductivity , Lee's disc method: theory and experiment ; conduction through compound media (series and parallel) ; thermal insulation , applications; heat exchangers: refrigerators and solar water heaters.

Unit-IV: Quantum Mechanics

Black body radiation; Compton effect: theory and experimental verification; wave particle duality; electron diffraction, concept of wave function and its physical significance, Schrödinger's wave equation: time independent and time dependent equations, particle in a one-dimensional rigid Box; tunneling (qualitative) : scanning tunneling microscope.

Unit-V: Introduction To Nano Science

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1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publications, 44th Edition, 2015. 2. Monty J. Strauss, Gerald J. Bradley and Karl J. Smith," Calculus", 3rd Edition, 2002.
References:
Reference Books:
1. Erwin Kreyszig, "Advanced Modern Engineering Mathematics", John Wiley and Sons (Asia) Ltd, 10th Edition, 2017. 2. Bali N. P and Manish Goyal," A Textbook of Engineering Mathematics", Laxmi Publication, 8th Edition, 2011. 3. Jain R.K. and Iyengar S.R.K, "Advanced Engineering Mathematics", Naros Publications, 3rd Edition, 2007.
Journals:
1. Handbook of Differential Equations: Ordinary Differential Equations: https://www.sciencedirect.com/handbook/handbook-of-differential-equations-ordinary-differential-equations 2. Abstract and Applied Analysis: https://onlinelibrary.wiley.com/journal/4058
Web Resources:
1. https://www.youtube.com/watch?v=NG9hkGQwT3k 2. https://www.youtube.com/watch?v=CogfMjKUGc0 3. http://videolectures.net/mit1803s06_mattuck_lec19/ 4. http://freevideolectures.com/Course/3244/Advanced-Engineering-Mathematics/12 5. https://www.youtube.com/watch?v=OUbMX4eQ5oM
MOOC/NPTEL/SWAYAM Courses:
1. http://nptel.ac.in/courses/111105035/22 2. http://nptel.ac.in/courses/111108081/ 3. *http://nptel.ac.in/courses/122102004/2*

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MA102.1	Compare the ideas of vector integral theorems for solving the problems and exhibit the relation between them.
R19MA102.2	Make use of Milne Thomson method to construct analytic functions related to complex variable.
R19MA102.3	Apply the concepts of integration for complex functions in certain regions to determine real integrals.
R19MA102.4	Apply Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.
R19MA102.5	Apply various techniques in solving differential equations.

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R19PH101.3	Have adequate knowledge on the concepts of thermal properties ofmaterials and their applications in expansion joints and heat exchangers.
R19PH101.4	Get knowledge on advanced physics concepts of quantum theory and itsapplications in tunneling microscopes.
R19PH101.5	Assess the principles of basic science concepts in evaluating and predictingmatter at nano scale.

R19CS103	**Data Structures and Algorithms**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

This course provides a comprehensive introduction to data structures and algorithms. Students will delve into the principles behind organizing and manipulating data efficiently, covering a wide array of topics including lists, stacks, queues, sorting algorithms, searching and algorithmic techniques. Through a combination of theoretical lectures, practical coding exercises, and real-world applications, students will gain a solid understanding of how to select and implement the appropriate data structures and algorithms to solve complex computational problems.

2.Course Objectives:

1. To build and work with linear and nonlinear data structures like arrays, linked lists, stacks, queues, trees, and graphs.
2. To discover data structures to solve real-world problems and scenarios, demonstrating an understanding of trade-offs and limitations
3. To equip students' skills in designing, implementing, and analysing tree-based solutions to complex problems
4. To familiarize the student with analysis of algorithmic efficiency, including time and space complexity, to evaluate and compare algorithm performance.
5. To make students to work on efficient solutions to complex problems using brute force and divide-and-conquer techniques

3.Syllabus

Unit-I: Linked Lists

Array vs Linked List - Types of Linked List: Singly - Doubly - Singly Circular - Doubly Circular– Operations on Linked List: Insertion-Deletion - Find Reverse – Modifying Linked List - Floyd's cycle finding algorithm (Slow pointer and Fast pointer) – XOR Linked List

Unit-II: Stacks and Queue

Stack: Implementation using array and linked list- Queue: Implementation using array and linked list – Priority Queue- Infix to Postfix Conversion - Postfix expression evaluation- Processing Function Calls – Call log management - Monotonic Stack and Queue

Unit-III: Trees and Graphs

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Nano Scale: Quantum Confinement, Quantumdot; Different forms of nano materials; Fabrication methods: Top down and bottom up approach, Ball milling, CVD, Properties of nano materials; Dendrimers; Coulomb blockade effects: Single electron phenomena and Single electron transistor; Carbon nano tubes: properties and applications.
Text Books:
1. Avathanulu, M.N. and Kshirsagar, P.G., "A text book of Engineering Physics", S. Chand and company, 2018. 2. Bhattacharya, D.K. and Poonam, T. "Engineering Physics", Oxford University Press, 2017. 3. Gaur, R.K. & Gupta, S.L. "Engineering Physics". DhanpatRai Publishers, 2012. 4. Halliday, D., Resnick, R. and Walker, J., "Principles of Physics", Wiley, 2015.
References:
Reference Books: 1. Arthur Beiser, "Concepts of Modern Physics", Tata McGraw Hill, 2017. 2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 3. 2010. 4. Tipler, P.A. &Mosca,G. "Physics for Scientists and Engineers with Modern Physics'.2007 5. Pandey, B.K. &Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012 6. C. Kittel, Introduction to Solid State Physics, John Wiley (1996) 7. A. J. Dekker, Solid State Physics, Macmillan (1986) **Journals:** 1. Journal of the Mechanical Behavior of Biomedical materials. 2. The Journal of Magnetism and Magnetic Materials **Video References:** 1. https://www.youtube.com/watch?v=YKpvYF0hVDE 2. https://www.youtube.com/watch?v=_JOchLyNO_w 3. https://www.youtube.com/watch?v=h6FYs_AUCsQ 4. https://www.youtube.com/watch?v=K0VY9_hB_WU 5. https://www.youtube.com/watch?v=0EokkhdppgE **MOOC/NPTEL/SWAYAM Courses:** 1. https://www.youtube.com/watch?v=p0cPzZWvDfc 2. https://archive.nptel.ac.in/courses/104/104/104104085/ 3. https://www.youtube.com/watch?v=fHsGYj1ZP1k

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19PH101.1	Learn the basic of properties of matter and its applications
R19PH101.2	Acquire knowledge on the concepts of optical devices and theirapplications in fibre optics

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R19EC103	Electronics And Microprocessors	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive introduction to the fundamental concepts of electronics and microprocessors, equipping you with the knowledge and skills to design and build basic embedded systems.

2. Course Objectives:

1. To facilitate understanding of semiconductor theory and diode operation
2. To teach BJT and FET operation and biasing techniques
3. To instruct on 8085 microprocessor architecture and assembly programming
4. To teach 8051 microcontroller architecture and instruction set
5. To explain interfacing principles and peripheral devices of the 8051

3. Syllabus:

Unit-I: Diodes and its Applications

Semiconductor – Commonly used semiconductors - intrinsic and extrinsic semiconductor - p type and n type semiconductor - PN junction diode: properties, biasing and VI characteristics –half wave rectifier with output frequency and center tap full wave rectifier with output frequency - Zener diode - Zener diode as voltage stabilizer.

Unit-II: Transistors and Amplifiers

Transistor – Transistor action - Transistor as an amplifier - CB, CE, CC connections and its comparison – transistor biasing - Field effect transistor: types, JFET, working principle, difference JFET and BJT –JFET as an amplifier and its output characteristics – MOSFET: types, circuit operation of D-MOSFET and E-MOSFET.

Unit-III: Introduction to Microprocessor

Introduction to Microprocessor and Buses - 8086 Architecture –Pin description – interrupt processing – operand addressing – assembler directives - instruction set (commonly used instructions only)

Unit-IV: Peripherals and Interface

8255 Programmable Peripheral Interface – 8251 Universal Synchronous and Asynchronous Receiver Transmitter - 8253 Timer – DAC – ADC.

Unit-V: Introduction to Microcontroller

Introduction to 8-bit microcontroller: 8051 architecture, memory organization, special function registers - port operation - timer/counters - serial interface - interrupts – operand addressing.

Text Books:

1. V.K.Mehta and Rohit Mehta, "Principles of Electronics" S.Chand, 12/e, 2014 (Unit I & II)
2. Krishna Kant, "Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096", PHI, 2013 (Unit III, IV & V)

Reference Books:

1. Robert Boylestad, Louis Nashelsky, "Electronic devices and Circuit theory", Pearson, 11/e, 2015
2. A.K.Ray and K.M.Bhurchandi, "Advanced Microprocessor and Peripherals", MGH, 3/e, 2017

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Terminologies - Binary Trees: Implementation – Traversals - Expression Trees - Binary Search Trees: Construction-Insertion-Deletion – Searching - Find Min - Find Max – Graph : Representation – Types - Traversals: Depth First Search (DFS)-Breadth First Search (BFS) – Minimum Spanning Tree (Prim's and Kruskal's algorithm) - Finding Shortest Path : Dijkstra's algorithm
Unit-IV: Sorting and Searching Techniques
Sorting: Internal Sorting - Bubble Sort - Insertion Sort - Quick Sort - Searching: Linear Search - Binary Search -Fundamentals of Algorithmic Problem Solving – Time complexity - Space complexity – Worst case – Average case – Best case
Unit-V: Algorithmic Techniques
Algorithmic techniques - Brute Force : Travelling Salesman Problem - Divide and Conquer: Merge sort - Dynamic programming: Knapsack Problem - Backtracking: n-Queen problem
Text Books:
1. Seymour Lipschutz," Data Structures using C", First Edition, McGraw Hill Education, 2017. 2. Reema Thareja, "Data Structures Using C", Second Edition, Oxford University Press, 2019. 3. Anany Levitin, —Introduction to the Design and Analysis of Algorithms‖, Third Edition, Pearson Education, 2012
Reference Books:
1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 1997. 2. Narasimha Karumanchi "Data Structures and Algorithms Made Easy" Fifth Edition, Career Monk Publications, 2017. 3. Salaria R S, "Data Structures and Algorithms using C", Fifth Edition, Khanna Book Publishing, New Delhi, 2012. 4. Sara Baase and Allen Van Gelder, —Computer Algorithms: Introduction to Design and Analysis, Pearson Publications, 3rd Edition, 2008.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS103.1	Understand and apply linked list concepts
R19CS103.2	Implement stacks and queues and perform operations on them
R19CS103.3	Construct trees and perform operations
R19CS103.4	Apply graphs in solving problems
R19CS103.5	Understand and apply the sorting, searching and hashing techniques

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Reading: Reading for Information Writing: Checklists, Process Description Grammar: Regular and Irregular Verbs, Discourse Markers, Single Word Substitute
Unit-II: Listening Comprehension
Reading: Reading Longer Texts and Practicing Speed Reading Writing: Job Application with Resume, Autobiographical Writing Grammar: If Conditionals, Active and Passive Voice
Unit-III: Presentation Skills
Reading: Reading Business Plans and Reports Writing: Memorandum, Circular, Notice, Agenda, Minutes of Meeting Grammar: Degrees of Comparison, Numerical Adjectives.
Unit-IV: Report Writing
Reading: Descriptive and Narrative Passages Writing: Report Writing, Types of Reports - Feasibility, Accidental and Incident Report Grammar: Using Idioms in Sentences, Simple, Compound and Complex Sentences.
Unit-V: Interview Skills
Reading: Intensive & Extensive Reading, Note-Making Writing: Preparing Technical Proposals Grammar: Extended Definitions - Reported Speech - Embedded Sentences.
List of Exercises: 1. Listening: Listening Comprehension and Answering 2. Speaking: Conversation Building 3. Listening: Listening to Various Technical Talks and Summarizing 4. Speaking: Describing a Process 5. Listening: Listening to Class Room Lectures and Seminars – Preparing Hints 6. Speaking: Process Description for a new product 7. Listening: Listening and Note taking practice 8. Speaking: Techniques to develop effective Presentation – Oral Presentation 9. Listening: Listening to Foreign Speakers and interpreting promptly **10.** Speaking: Reviews (Books, Novels & Movies)- Technical Presentation
Text Books:
1. Jack C. Richards, "Interchange Student's Book 1", Cambridge University Press; Fourth Edition, 2015. 2. S. N. Mahalakshmi, "Technical English for Engineers", V. K. Publications; Chennai, Eighth Edition, 2020.
References:

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3. Mohammed Ali Mazidi, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson, 2/e, 2012

Journals:

1. IEEE Transactions on Electronics Devices
2. Microelectronics Journal

Web Resources:

1. https://www.allaboutcircuits.com/
2. https://www.electronics-tutorials.ws/

MOOC / NPTEL / SWAYAM Courses:

1. https://onlinecourses.nptel.ac.in/noc22_ee12/preview
2. https://archive.nptel.ac.in/courses/117/103/117103063/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC103.1	Understand the basics of semiconductor theory and working of diodes
R19EC103.2	Understand the working of BJT and FET and Biasing techniques
R19EC103.3	Apply the architecture of 8086 microprocessor and Use instruction set
R19EC103.4	Understand the working of peripheral ICs and its interface with microprocessor
R19EC103.5	Apply the architecture of 8051 microcontroller and instruction set

R19HS551	Business English	L	T	P	C
		2	0	2	3

1. Course Description:

This course is designed to develop a complete view of Communication, its scope and importance to the learners. The Learners will be introduced to a range of situations, which will enhance their understanding of the Communication Process and develop their Practical Skills in Listening, Speaking, Reading and Writing. Further, this course will enable the learners to plan for effective presentation by gathering relevant information, determining audience needs, and defining presentation purpose.

2. Course Objectives:

1. Develop strategies and skills to enhance their ability to read and comprehend Engineering and technology texts.
2. Strengthen their listening skills which will help them to comprehend lectures and talks in their areas of specialization.
3. Develop their speaking skills to make technical presentations.
4. Foster their ability to write convincing job applications and effective reports.
5. Build their confidence to participate in Group discussion.

3. Syllabus:

Unit-I: Types of Conversation

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Reference Books:

1. Rizvi M.Ashraf, "Effective Technical Communication", Tata McGraw Hill Publishing Company; New Delhi, 2015.
2. Andrea J.Rutherford, "Pearson Education" Inc. and The Darling Kindersley Publishing Inc., 2020.
3. Raman, Meenakshi and Sharma, Sangeetha "Technical Communication Principles and Practice", Oxford University Press; New Delhi, 2019.
4. Richards C. Jack, "Interchange", Fourth edition; Cambridge University Press, 2020.
5. Butterfield, Jeff, "Soft skills for Everyone", Sixth Indian Reprint, 2018.

Video References:

1. https://www.youtube.com/watch?v=tBtc6rpcMz4
2. https://www.youtube.com/watch?v=Ll23cChDSKE
3. https://www.youtube.com/watch?v=fyAtyAdCStM

Web References:

1. https://leo.stcloudstate.edu/grammar/subverag.html
2. http://www.learningdifferences.com/Main%20Page/Topics/Compound%20Word%20Lists/Compound_Word_%20Lists_complete.htm
3. http://examples.yourdictionary.com/examples-of-active-and-passive-voice.html
4. http://www.perfectyourenglish.com/grammar/numeral-adjectives.htm
5. https://en.wikipedia.org/wiki/Commonly_misspelled_English_words
6. https://www.englisch-hilfen.de/en/grammar/if.htm
7. http://www.englishforeveryone.org/Topics/Reading-Comprehension.htm

MOOC/SWAYAM/NPTEL Courses:

1. https://onlinecourses.nptel.ac.in/noc22_hs05/preview
2. https://onlinecourses.nptel.ac.in/noc23_hs72/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS551.1	Develop fundamental professional communication skills to effectively navigate and overcome barriers in business conversations.
R19HS551.2	Construct professional emails, memos, and letters, and draft formal business reports and proposals.
R19HS551.3	Develop skills in negotiation and persuasion, recognize cultural differences, and use conflict resolution strategies in business.
R19HS551.4	Plan and deliver well-structured business presentations with effective visual aids.
R19HS551.5	Build organized business reports, executive summaries, and documentation with precision and clarity.

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R19HS552	Basic Japanese	L	T	P	C
		2	0	2	3

1. Course Description:

The primary objective of this course is to provide a solid foundation in speaking, listening, reading, and writing Japanese. Through interactive lessons and practical exercises, you'll learn essential vocabulary, grammar structures, and pronunciation. Additionally, this course will introduce the various facets of the Japanese culture with cultural insights and real-life scenarios, thereby enhancing their awareness of the cultural subtleties inherent in the language.

2. Course Objectives:

1. Develop proficiency in basic Japanese language skills including speaking, listening and reading and writing to facilitate effective communication in everyday situations.
2. Acquire a solid understanding of the fundamental Japanese grammar structures, vocabularies and pronunciations to construct simple sentences and engage in basic conversations.
3. Enhance language proficiency through interactive activities, role-plays and rea-life scenarios, fostering practical language usage and confidence in communication.
4. Build a foundation for further language study and cultural exploration, enabling the students to pursue advanced language proficiency and deeper cultural understanding.

3. Syllabus

Unit-I: Introduction to Japanese Scripts and Basic Greetings

Japanese Scripts (Hiragana & Katakana) – Daily greetings and expressions – Introduction to grammar particles – N1 wa N2desu - N1 wa N2ja arimasen – Phrase/Sentence ka – N1 mo N2desu - N1 no N2desu – Honorific suffixes (san, kun, chan) – Demonstrative words (Ko, So, A & Do series) – Soudesu – Soudesuka – Soudesune – Sou ja arimasen/Chigaimasu – S1 ka S2 ka - N1(noun) wa N2(place)desu – Numbers – Days of the week – Days of the month

Unit-II: Introduction to Concept of Time

Ji, fun, pun – Ima wa nan ji desuka – Introduction to verbs (group I, group II, group III verbs) – Verb tense forms – V masu – V mashita – V masen – V masendeshita – N(time) ni V - N1 kara N2made - N1 to N2– N to V – S ne – N(place) e ikimasu/kimasu/kaerimasu – Doko(e) mo ikimasen/ikimasendeshita – itsu – S yo - Introduction to de particle – N(place) de V – N(vehicle) de ikimasu/kimasu/kaerimasu – N(tool) de V – N o V(transitive) – N o Shimasu – Usage of nan and nani – V masenka – V mashou, mashouka – Honorific prefixes(o/go) – "word/sentence" wa ~go de nan desuka – N(person) ni agemasu/moraimasu/kuremasu – V mou mashita.

Unit-III:Introduction to Adjectives

I ending adjectives – na ending adjectives – forms of adjectives(negative form, past form) – I ending adjective →ku/Na ending adjective→ni narimasu – degrees of adjectives – S1 ga S2 – N ga adjective – N ga arimasu/wakarimasu – degrees of adverbs – degrees of quantity – S1 kara S2 – Doushite – N1(place) ni N2(noun) ga arimasu – N1(noun) wa N2(place) ni arimasu/imasu – N1(noun) no N2(position) – N1 ya N2 nado.

Unit-IV:Introduction to Counters

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Counters for objects – Counters for person – Ikutsu – nan+counter suffix – kurai and gurai – Quantifier(period) ni frequency counter(kai) – Quantifier/Noun+dake - N1 wa N2 yori "adjective" desu - N1 to N2to Dochira ga "adjective" desuka – N no naka de nani/doko/dare/itsu ga "adjective" desuka – Interrogatives ka/mo/demo.
Unit-V: Verb Conjugations and their Usages
5.1: V masu form and its usages N ga hoshii desu – V masu form tai desu – V masu form ni ikimasu/kimasu/kaerimasu – V masu form mashouka. 5.2: V te form and its usages V te form kudasai – V te form imasu – V te form mo iidesu – V te form wa ikimasen – shirimasu, shirimasen, shitte imasu – te form of adjectives – V1 te form kara V2 – douyatte – V te form agemasu/kuremasu/moraimasu 5.3: V nai form and its usages V nai form de kudasai – V nai form kereba narimasen – V nai form to – V nai form kutemo iidesu – N(time) madeni V. 5.4: V dictionary form and its usages V dictionary form koto ga dekimasu – Shumi wa N suru/V dictionary form koto desu – N no/Quantifier(time)/V1 dictionary form maeni V2 – nakanaka – zehi/zettai/mochiron – V dictionary form jikan/youji/yakusoku. 5.5: V ta form and its usages V ta form koto ga arimasu – V ta ri, V ta ri Shimasu – usage of plain form and polite form – kedo – noun modification using V plain form – V plain form/N no toki ~. 5.6: If clause V dictionary form to~ - V ta form ra~ - V te form/I adj→kute/Na adj→de/N de mo~ - moshi/ikura~.
Text Books:
1. Minna no Nihongo, Japanese for Everyone: Elementary main textbook 1-1 & 1-2". 1st edition, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007. 2. "Basic Kanji 320", published by Meguro Language Centre, Tokyo.
References
Reference Books: 1. "Genki: An Integrated Course in Elementary Japanese" authored by Eri Banno, Yoko Ikeda, and Yutaka Ohno, latest edition published in 2011 by The Japan Times. 2. "Nihongo So-matome: JLPT N5 grammar" authored and published by Ask Publications, latest edition 2021. **Web Resources:** 1. www.japaneselifestyle.com 2. www.learn-japanese.info/ 3. www.kanjisite.com/ 4. www.learn-hiragana-katakana.com/typing-hiragana-characters/

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS552.1	Recognize and write the Japanese alphabet without errors
R19HS552.2	Extend the conversation using basic sounds in the Japanese language
R19HS552.3	Explain the concept of time by learning verbs, tenses and vocabularies.
R19HS552.4	Make use of the appropriate vocabulary required for simple conversations in the Japanese language.
R19HS552.5	Comprehend the conversation and give the correct meaning

R19HS553	Basic German	L	T	P	C
		2	0	2	3

1. Course Description

This German language course offers a structured approach to learning German, spanning from basic introductions to more complex grammatical concepts and practical applications. Beginning with an introduction to German scripts and daily greetings, participants progress through units covering essential grammar topics, vocabulary expansion, and pronunciation exercises. Throughout the course, students engage in speaking activities, such as introducing themselves, ordering food, and describing their surroundings, while also focusing on listening comprehension and reading comprehension. By the end of the course, participants will have gained proficiency in basic conversational German, acquired foundational knowledge of German grammar and vocabulary, and developed the skills necessary to navigate everyday situations in a German-speaking environment.

2. Course Objectives:

1. Basic German introduces learners to essential language components such as vocabulary, grammar, pronunciation, and basic conversational phrases.
2. Through interactive lessons and practical exercises, students develop the ability to communicate in basic German for everyday scenarios including greetings, introductions, shopping, dining, and navigating daily life situations.
3. Additionally, learners become familiar with the German alphabet, basic sentence structure, and common expressions, facilitating basic reading and writing skills.

3. Syllabus

Unit-I: Basic Introduction to German Scripts

Theme and Text (Introduction to German - German script, Deutsche Namen, Daily Greetings and Expressions) – Grammar ('wh' questions, das Alphabet)– Speak Action (Buchstabieren, sich und andere vorstellen nach Namen und Herkunft fragen, internationale Wörter auf Deutsch verstehen, jemanden begrüßen)– pronunciation (Buchstabieren J,V,W,Y, - Long

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vowels A,E,I,O,U - Pronunciation of Ä,Ü,Ö) – To learn (internationale Wörter in Texten finden, Wörter sortieren) Theme and Text (Gespräche im caf'e, Getränkekarte, Telefon-buch, Namen, Rechnungen) – Grammar (Frägesatze mit wie, woher, wo, was Verben in präsens Singular und Plural, das Verb Sein, Personalpronomen und Verben)– Speak Action (eine Gespräch beginnen sich und andere vorstellen zählen, etwas bestellen und bezhalen Telefonnummern und verstehen)– pronunciation (Wortakzent in Verben und in Zahlen) – To learn (Grammatiktabelle ergänzen, mit einem Redemittelkasten arbeiten)
Unit-II: Numbers and Nominative Case
Theme and Text (Numbers – 1 to 12 (Eins bis Zwolf) – 20, 30, 40, 90 (zwanzig-Neunzig) – All Numbers (1-10000) – German Currency (Euro) – Basic Mathematics (plus, Minus, Malen, Geteilt durch)) – Grammar (Introduction of verbs –Have Verb – To Come, To Speak, To Read, To Drive, To Fly, To write, To Eat, To sleep, To take etc.,) Theme and Text (Communication in course) – Grammar (Singular and Plural, Artikel: der,das,die/ ein,eine, verneinung: kein, keine, Komposita: das Kursbuch) – Speak Action (Gegenständen fragen/ Gegenstände benennen im kurs:) – pronunciation (word accent Marking, Umlaute ö ä ü hören und sprechen) – To learn (Lernkarten schreiben, Memotipps, eine Regel selbst finden) Theme and Text (City, Town, Language: Nachbar, Sprachen, Sehenswürdigkeiten in Europa) – Grammar (Past tense for Sein, W-Frage, Aussagesatz und Satzfrage) – Speak Action (about city and siteseeing) – pronunciation (Satzakzent in Frage- und Aussagesätzen) – To learn (eine Regel ergänzen, eine Grammatiktabelle erarbeiten, Notizen machen)
Unit-III:Akkusative Case and Prepositions
Theme and Text (Menschen und Hauser, Furniture catalogue, E-Mail, House information) – Grammar (possesivartikel im Nominativ, Artikel im Akkusativ, Adjektive im satz, Graduierung mit zu)– Speak Action (Whonung bescreiben about perons and things)– pronunciation (consonant - ch) – To learn (wortschatz systematisch) Theme and Text (Termine - Appointment and punctuality in Germany) – Grammar (questions with wann?, Preposition (am, um, von... bis), verneinung mit nicht, trennbare verben, präteritum von haben) – Speak Action (Daily plan making, time commitment, excuse for late coming) – pronunciation (consonants- p,b,t,d / k,g) – To learn (Rollenkarten arbeiten) Theme and Text (orientation in the working area, go for work, floor plan city plan, office and computer) – Grammar (preposition: in,neben, unter, auf, vor, hinter, an, zwischen, bei und mit + Datic)– Speak Action (workplace, work, giving appointments)– pronunciation (consonants: f,w und v) – To learn (Making notice in the calendar)
Unit-IV:Dativ Case and Prepositions
Theme and Text (Holiday and Party, holiday plan, party plan in Germany) – Grammar (regular and irregular verbs) – Speak Action (holiday speak, accident, Ich-Text schreiben) – pronunciation (lange und kurze vokale markieren) – To learn (Text Order) Theme and Text (organising an Excursion to Berlin through city orientation, Bus plan, City plan, postcard, Excursion programme) – Grammar (preposition: in, durch, über + Akkusativ: zu, an... vorbei + Dativ, Modalverb wollen) – Speak Action (Tourism, culture, postcard preparation, travel description) – pronunciation (r and l)– To learn (plaket making)

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Theme and Text (Beruf und all Tag, Visiten karten, wörterbuch) – Grammar – Speak Action (profession, statistic speaking) – pronunciation (n,ng and nk)– To learn (wörterbuch , text information in tabel)
Unit-V: Adjectives and Pronunciation
Theme and Text (Haushaltstipp, kochrezept, maße und gewichte, Mahlzeiten und Gerichte) – Grammar (jeden Tag, manchmal, nie, Question - welche, Comparison – viel, gut, gern) – Speak Action (about eat, drink question and answers) – pronunciation (e,en,el,er) – To learn (Text auswerten und zusammenfassen) Theme and Text (Clothing , colour, weather) – Grammar (Adjecktive im Akkusativ, unbestimmer Artikel) – Speak Action (weather, dress and colour understanding) – pronunciation (e-o- ö and ie-u- ü) – To learn (wetter and Farben interkulturelle) Theme and Text (in supermarket,purchase, House Maintenance, Emotions, Sports, Body parts) – Grammar (Modal Verb) – Speak Action (Body parts) – To learn (Rollenkarten arbeiten)
Text Books: 1. Funk, Kuhn, Demme, "Studio D A1 Deutsch als Fremdsprache" Goyal Publishers and Distributors; 2016 2. Hueber, "Fit for Goethe- Zertifikat A1 (Start Deutsch 1)" Goyal Publishers and Distributors; 2016
References:
Reference Books: 1. Stefanie Dengler, "Netzwerk Deutsch Als Fremdsprache A1" by Goyal Publishers & Distributors Pvt Ltd 2. Fran Martin, "Grammar Tables for Student of German" by Independently Published, 2017 **Web Resources:** 1. www.memrise.com/courses/english/german/ 2. www.deutsch-lernen.com/ 3. www.duolingo.com

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS553.1	Recognize and write the German alphabet
R19HS553.2	Speak using basic sounds of the German language
R19HS553.3	Apply appropriate vocabulary needed for simple conversation in the German language
R19HS553.4	Apply appropriate grammar to write and speak in the German language
R19HS553.5	Comprehend the conversation and give the correct meaning

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R19CS151	Python Programming	L	T	P	C
		3	0	2	4

1.Course Description:

This course covers the fundamental concepts and practical applications of Python programming. Students will explore topics ranging from basic data types and expressions to advanced data manipulation and visualization techniques. The course will explores into programming paradigms, emphasizing Python's versatility in supporting imperative, functional, and object-oriented programming styles. Through hands-on exercises, projects and real-world examples, students will develop a strong foundation in Python programming, enabling them to write efficient, readable and maintainable code for a variety of applications.

2.Course Objectives:

1. To make students to write efficient, readable, and well-structured code
2. To choose and use data structures such as lists, tuples, dictionaries and sets in Python programs
3. To make students to effectively organize, structure, and manage Python code using files, modules, and packages
4. To implement object-oriented programming constructs in Python
5. To use libraries for data analysis in Python and use Django framework for web application development

3.Syllabus

Unit-I: Data, Expressions, Statements

Introduction: Python Interpreter and interactive mode, comments, Identifiers and Keywords; Data types: int, float, Boolean, String; Variables and Expressions; Operators: types, precedence

Illustrative Programs: Financial application, Health care application

Unit-II: Programming Paradigms

Conditional Statements: conditional (if), alternative (if-else), chained conditional (if-elif-else); Looping Statements: while, for; Jump Statements: break, continue, pass; Fruitful Functions: return values, parameters, local and global scope, function composition, recursion; Strings: slices, immutability, functions and methods; Python-DB connectivity

Illustrative Programs: Towers of Hanoi, Kadane's Algorithm, and Chocolate Distribution Algorithm

Unit-III: Lists, Tuples and Dictionaries

Lists: operations, slices, methods, loop, mutability, aliasing, cloning, parameters, lists as arrays; Tuples: assignment, tuple as return value; Dictionaries: operations and methods; Sets: operations

Illustrative Programs: Dutch National Flag Algorithm, Count and Say Problem

Unit-IV: Files, Modules and Packages

Files: text files, reading and writing files; Format Operator; Command Line Arguments; Error and Exception Handling; Modules; Packages; Introduction to Tkinter; Introduction to Open CV

Illustrative Programs: Word count, File copying

Unit-V: Data Manipulation and Data Visualization

NumPy: Basics of NumPy Arrays; Computations: Universal Functions; Aggregations: Min-Max and Everything In Between; Pandas: Objects, Data Indexing and Selection, Data Operations, Handling Missing Data; Matplotlib: Types of plots, Simple Line Plots, Boxplots, Simple Scatter Plots

Case study: Analyze the performance of cricket players and plot a graph

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3.List of Laboratory Experiments / Exercises:
1. Design a flowchart to address a real-world problem of your choice. Suggested Problems: Traffic signal control / Water level controller / Temperature control system / Automatic washing machine control system / Automatic Street light control system / Electricity Billing / Retail shop billing/Computing Electrical Current in Three Phase AC circuits (Minimum three problems) 2. Create a Python application that uses expressions and control flow statements to automate a common task. Ensure that your application is user-friendly and robust to different inputs. Suggested Problems: Swap two numbers without a temporary variable, Quadratic Equation, Valid Palindrome 3. Implement a Python program that simulates a real-world system or process using conditions and iterative loops. Suggested Problems: check whether an alphabet is a vowel or consonant, sum of all even numbers from 0 to n, factorial of a number 4. Implementation of real-time/technical applications using Lists and Tuples(Minimum Index Sum of Two Lists, Concatenate two lists index-wise, Tuple with the same product, Copy specific elements from one Tuple to a new tuple) 5. Implementation of real-time/technical applications using Set and Dictionaries (Magic Dictionary, Longest Word in Dictionary, Set Mismatch and Smallest Number in Finite Set) 6. Implementation of Functions in the program (Factorial, largest number in a list, area of shape) 7. Implementation of Strings in the program (Determine if string halves are alike, palindrome, character count, replacing characters) 8. Implementation of file-handling operations (copy from one file to another, word count, longest word) 9. Implementation of libraries (Pandas, NumPy, Matplotlib) 10. Implementation of applications of standard libraries (Handle scalars to work on the NumPy array, Insert values at random positions in an array, Convert the index of a series into a column of a data frame, Combine many series to form a data frame, Get frequency counts of unique items of a series, Union of two arrays, Convert a NumPy array to a data frame of a given shape, Plotting datasets) 11. Mini Project: Develop an application for any real-world problem
Text Books:
1. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners," 2nd Edition, No Starch Press, 2019 2. Liang Y. Daniel, "Introduction to Programming Using Python", Pearson Education, 2017 3. Alan D. Moore, "Python GUI Programming with Tkinter: Develop responsive and powerful GUI applications with Tkinter," Packt Publishing Limited, 2018
References:
References Books:
1. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-Disciplinary Approach," Pearson India Education Services Pvt. Ltd., 2016 2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist," Second edition, Updated for Python 3, Shroff O'Reilly Publishers, 2016 3. Timothy A. Budd," Exploring Python," Mc-Graw Hill Education (India) Private Ltd., 2015

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Web Resources:

1. https://www.coursera.org/specializations/python
2. https://jakevdp.github.io/PythonDataScienceHandbook/02.00-introduction-to-numpy.html

MOOC/NPTEL /SWAYAM Courses:

1. https://www.coursera.org/specializations/python
2. https://www.coursera.org/learn/python-crash-course
3. https://NPTEL.ac.in/courses/106106145

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS151.1	Apply syntax and semantics of Python programming language for developing real-world applications
R19CS151.2	Write python functions to facilitate code reuse and manipulate strings
R19CS151.3	Develop Python solutions by implementing lists, tuples, and dictionaries
R19CS151.4	Apply advanced skills in utilizing built-in functions for file system applications
R19CS151.5	Analyse data manipulation and visualization and demonstrate them in real time applications

R19PH111	Physics Laboratory	L	T	P	C
		0	0	2	1

1. Course Description:

This course is designed to lay a strong foundation in Engineering Physics that forms a basis to various branches of Engineering. It helps the students to perform experiments, to correlate theory with experimental data, analyse using graphical representations and present them as part of a clear, well-organized lab report. At the end of the course, students will be able to demonstrate a working knowledge of fundamentals of Physics and communicate their ideas effectively, both orally and in writing.

2. Course Objectives:

To enable the students to

1. Demonstrate competency and understanding of the basic concepts found in experimental Physics.
2. Estimate the error in measurements and the ability to prepare a valid laboratory record.
3. Understand the measurement techniques and usage of instruments in physics.

List of Experiments:

1. Compute the Young's modulus of the given material using uniform bending.
2. Calculate the Rigidity modulus of the given wire using torsional oscillation method.
3. Determine the coefficient of viscosity of given liquid by Poiseuille's flow method
4. Estimate the wavelength of LASER using diffraction grating.
5. Calculate the energy band gap of a given semiconductor diode.

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6. Estimate the thermal conductivity of a bad conductor using Lee's Disc Method
7. Enumerate the wavelength of Mercury spectrum using spectrometer
8. Compute and analyse the energy loss using B-H curve of a ferromagnetic material.

Text Books:

1. In house laboratory manual "Physics Manual" prepared by the faculty members (Physics) –Sri Eshwar College of Engineering – Coimbatore.

References:

1. C. L. Arora, "Practical Physics", S. Chand & Co., New Delhi, 3rd Edition, 2012.
2. Dr.T. Radhakrishna, "Practical Physics for Engineering Students", SM Enterprises, 2nd Edition, 2014.

4. Course Outcomes:
After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19PH111.1	Develop skills to impart practical knowledge in real time solutions.
R19PH111.2	Interpret and formulate experiments in engineering physics.
R19PH111.3	Develop skills to impart practical knowledge in real time solutions.
R19PH111.4	Design new experiments with practical knowledge.
R19PH111.5	Apply deep knowledge about the solution to theoretical problems.

R19ME111	Computer Aided Drafting And Modelling Laboratory	L	T	P	C
		0	0	4	2

1. Course Description

This course provides an introduction to computer-aided drafting. Emphasis is placed on setup, creating and modifying geometry, storing and retrieving predefined shapes, placing, rotating, and scaling objects, adding text and dimensions using layers, coordinate systems, and plot/print to scale.

2. Course Objectives:

1. To develop skill to use software to create 2D and 3D models.
2. To apply basic concept to drawing, edit, dimension, hatching etc. to develop 2D & 3D Modelling.

3. List of Experiments

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) –Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drafting of given 2D drawings.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views(eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Draw the Assembled Sectional views of Gib and Cotter using AutoCAD.
7. Draw the Assembled Sectional views of screw jack using AutoCAD.

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8. Draw the Assembled Sectional views of Machine Vice using AutoCAD. 9. Drawing isometric projection of simple objects. 10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.
Reference Books:
1. George Omura, Mastering in Autocad 2005 and Autocad LT 2005– BPB Publications, 2008 2. Engineering graphics with Auto CAD- R.B. Choudary/Anuradha Publishes
Video Reference:
1. https://www.youtube.com/watch?v=LJAg9a0sd2g

4. Course Outcomes

After successful completion of the course, the student should be able to:

CO	Course Outcome
R19ME111.1	(Apply) Draw the title block and curves like parabola, involutes and solids for given experiments.
R19ME111.2	(Apply) Apply fundamental knowledge and basic skill to draft and model for given 2D drawings
R19ME111.3	(Apply) Develop 2D representations of 3D objects using CAD software
R19ME111.4	(Analyze) Analyse and develop 2D and 3D models in relevance to given drawings using CAD Software
R19ME111.5	(Create) Create part drawings, sectional views and assembly drawings as per standards for the given components

R19CS113	**Data Structures and Algorithms Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**
1. Course Description:					
The Data Structure and algorithms Laboratory is a hands-on course designed to complement theoretical knowledge with practical implementation skills in data structures. Through a series of lab sessions, students will work on implementing code and projects focusing on lists, stacks, queues, sorting algorithms, searching techniques, hashing, trees and graph data structures. By actively engaging in coding exercises and projects, students will deepen their understanding of the course, enhance their programming skills, and gain valuable experience applicable across various domains of computer science and engineering.					
2.Course Objectives:					
1. To build and work with linear and nonlinear data structures like arrays, linked lists, stacks, queues, trees, and graphs. 2. To discover data structures to solve real-world problems and scenarios, demonstrating an understanding of trade-offs and limitations					

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3. To equip students' skills in designing, implementing, and analysing tree-based solutions to complex problems
4. To familiarize the student with analysis of algorithmic efficiency, including time and space complexity, to evaluate and compare algorithm performance.
5. To make students to work on efficient solutions to complex problems using brute force and divide-and-conquer techniques

3.List of Laboratory Experiments:

1. Implementation of Singly and Doubly linked list
2. Implementation of Stack and Queue using Linked list
3. Demonstration of applications of Stack (Infix to Postfix conversion)
4. Implementation of Binary Search Tree operations and Traversal
5. Implementation of Binary Search Tree Traversal
6. Implementation of Graph Traversals
7. Implementation of Dijkstra's algorithm for Shortest Minimum Path
8. Implementation of Minimum Spanning Tree (Prim's and Kruskal's algorithm)
9. Implementation of Sorting Algorithms (Bubble/Insertion/Quick)
10. Implementation of Searching Techniques (Linear Search, Binary Search)
11. Demonstration of Brute Force(Travelling Salesman Problem)
12. Demonstration of Divide and Conquer(Merge sort)
13. Demonstration of Dynamic programming(Knapsack Problem)
14. Demonstration of Backtracking(n-Queen problem)

Text Books:

1. Mark A.Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2010.
2. Karumanchi Narasimha," Data Structures and Algorithms Made Easy", Fifth Edition, Career Monk Publication, 2016.
3. Sara Baase and Allen Van Gelder, —Computer Algorithms: Introduction to Design and Analysis, Pearson Publications, 3rd Edition, 2008.

References Books:

1. Reema Thareja, "Data Structures Using C", Second Edition, Oxford University Press, 2019
2. Narasimha Karumanchi "Data Structures and Algorithms Made Easy" Fifth Edition, Career Monk publications,2017
3. Seymour Lipschutz, "Data Structures using C", First Edition, McGraw Hill Education, 2017

Web Resources:

1. https://www.geeksforgeeks.org/data-structures
2. https://www.javatpoint.com/data-structure-tutorial

MOOC/NPTEL /SWAYAM Courses:

1. https://www.udemy.com/course/datastructurescncpp/
2. https://in.coursera.org/learn/data-structures?action=enroll

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS113.1	Apply the concepts of linked lists by demonstrating and understanding of their implementation and usage to solve given problems
R19CS113.2	Construct stacks and queues using arrays and linked lists and apply these structures to appropriate scenarios
R19CS113.3	Implement tree data structures and their operations to enhance data management and retrieval systems
R19CS113.4	Assess graph-based algorithms to solve complex problems requiring efficient data traversal and manipulation
R19CS113.5	Examine sorting, searching and hashing algorithms to organize and retrieve data effectively

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R19MC101	தமிழர் மரபு / Heritage of Tamils	L	T	P	C
		1	0	0	1

1. Course Description / பாடநெறி விளக்கம்

This course is taught to provide insight to the students into the rich culture and heritage of the state. The students should know the valued things such as historic buildings that have been passed down from previous generations and relating to things of Tamil historical and cultural value that are worthy of preservation. This course explains the growth of nationalism, the growth of the Tamil language, various religious reformers, the spread of the Dravidian movement and its possible impact on society, the role of the self-respect movement, educational development in Tamilnadu since independence and the growth of fine arts in Tamilnadu.

மாநிலத்தின் வளமான கலாச்சாரம் மற்றும் பாரம்பரியம் பற்றிய நுண்ணறிவை மாணவர்களுக்கு வழங்க இந்த பாடநெறி கற்பிக்கப்படுகிறது. முந்தைய தலைமுறையினரிடமிருந்து பெறப்பட்ட வரலாற்று கட்டிடங்கள் மற்றும் தமிழ் வரலாற்று மற்றும் கலாச்சார மதிப்புள்ள விஷயங்கள் பாதுகாக்கப்பட வேண்டிய மதிப்புமிக்க விஷயங்களை மாணவர்கள் அறிந்து கொள்ள வேண்டும். தமிழ்நாட்டின் தேசியத்தின் வளர்ச்சி, தமிழ் மொழியின் வளர்ச்சி, பல்வேறு சமய சீர்திருத்தவாதிகள், திராவிட இயக்கத்தின் பரவல் மற்றும் சமுதாயத்தில் அதன் தாக்கம், சுயமரியாதை இயக்கத்தின் பங்கு, சுதந்திரத்திற்குப் பிறகு தமிழகத்தில் கல்வி வளர்ச்சி மற்றும் தமிழகத்தில் நுண்கலைகளின் வளர்ச்சி பற்றி இந்த பாடநெறி விளக்குகிறது.

2. Course Objectives / பாடத்தின் நோக்கங்கள் :

1. To make an inference about language and traditional of the state.
   மாநிலத்தின் மொழி மற்றும் பாரம்பரியம் பற்றி அனுமானிக்க உதவுகிறது.
2. To acquire knowledge in construction of status and various musical instruments
   கட்டிடக்கலை மற்றும் பல்வேறு இசைக்கருவிகளை உருவாக்குவதற்கான அறிவைப் பெறுதல்.
3. To study the detailed information about folklore and paramilitary arts.
   நாட்டுப்புறவியல் மற்றும் ராணுவக் கலைகள் பற்றிய விரிவான தகவல்களைப் படிக்க உதவுகிறது.
4. To gain knowledge of rich culture and success history of ancient kingdoms.
   பண்டைய ராஜ்யங்களின் வளமான கலாச்சாரம் மற்றும் வெற்றி வரலாற்றைப் பற்றிய அறிவைப் பெற உதவுகிறது.
5. To acquaint the student with the knowledge of Siddha medicine and about the Indian freedom struggle.
   சித்த மருத்துவம் மற்றும் இந்திய சுதந்திரப் போராட்டம் பற்றிய அறிவை மாணவருக்கு அறிமுகப்படுத்துதல்.

3. Syllabus / பாடத்திட்டங்கள்:

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Unit-I / அலகு-I: Language and Literature / மொழி மற்றும் இலக்கியம்
Language Families in India – Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature – Management Principles in Thirukkural – Tamil Epics and Impact of Buddhism & Jainism in Tamil Land – Bakthi Literature Azhwars and Nayanmars – Forms of minor Poetry – Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidhasan. இந்திய மொழி குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துகள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழிலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.
Unit-II / அலகு - II: Heritage–Rock Art Paintings to Modern Art –Sculpture / மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக்கலை
Hero stone to modern sculpture – Bronze icons – Tribes and their handicrafts – Art of temple car making – Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments – Mridhangam, Parai, Veenai, Yazh and Nadhaswaram – Role of Temples in Social and Economic Life of Tamils. நடுக்கல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினை பொருள்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரி முனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, யாழ், வீணை, நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு
Unit-III / அலகு-III: Folk and Martial Arts / நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance – Sports and Games of Tamils. தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம் - தமிழர்களின் வீர விளையாட்டுகள்.
Unit-IV / அலகு-IV: Thinai Concept of Tamils / தமிழர்களின் திணைக்கோட்பாடுகள்
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram Concept of Tamils – Education and Literacy during Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age – Overseas Conquest of Cholas.

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தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்க கால நகரங்களும் துறை முகங்களும் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.
Unit-V/ அலகு-V: Contribution Of Tamils To Indian National Movement And Indian Culture / இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு
Contribution of Tamils to Indian Freedom Struggle – The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement – Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books. இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிற்ப்பகுதியில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுய மரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.
Text Books:
1. தமிழக வரலாறு - மக்களும் பயன்பாடுகளும் - கே கே பிள்ளை (தமிழக பாட நூல் கழகம் மற்றும் கல்வியல் பணிகள் கழகம்). 2. கணினித் தமிழ் - முனைவர் இல .சுந்தரம் (விகடன் பிரசுரம்) . 3. கீழடி - வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம் (தொல்லியல் துறை வெளீயீடு). 4. பொருநை - ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு). 5. Social Life of Tamils - Dr.K.K.Pillay, A joint publication of TNTB & ESC and RMRL – (in print). 6. Social Life of the Tamils - The Classical Period - Dr.S.Singaravelu (Published by: International Institute of Tamil Studies. 7. Historical Heritage of the Tamils - Dr. S. V. Subatamanian, Dr. K. D. Thirunavukkarasu (Published by: International Institute of Tamil Studies). 8. The Contributions of the Tamils to Indian Culture - Dr.M.Valarmathi (Published by: International Institute of Tamil Studies). 9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation Tamil Nadu). 10. Studies in the History of India with Special Reference to Tamil Nadu - Dr.K.K.Pillay.
References:
1. Journey of Civilization Indus to Vaigai - R. Balakrishnan, Published by: RMRL. 2. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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4. Course Outcomes/ பாடநெறி முடிவுகள்:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome / பாடநெறி முடிவுகள்
R19MC101.1	To know about the language families in India, the impact of the religions, and the contribution of Bharathiar and Bharathidhasan. இந்தியாவில் உள்ள மொழி குடும்பங்கள், மதங்களின் தாக்கம், பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு பற்றி தெரிந்து கொள்வது.
R19MC101.2	Observe the growth of sculpture making of musical instruments and the role of temples in socio and economic lives. தமிழர்களின் வாழ்வில் இசைக்கருவிகள், சிற்பங்களை உருவாக்கும் முறைகள், சமூக, பொருளாதார வளர்ச்சி மற்றும் கோவில்களின் பங்களிப்பு பற்றி அறிந்து கொள்வது
R19MC101.3	Understand the significance of folklore and martial arts. நாட்டுப்புறவியல் மற்றும் தற்காப்புக் கலைகளின் முக்கியத்துவத்தைப் புரிந்து கொள்வது.
R19MC101.4	Learn the Sangam literature, Sangam age and overseas conquest of Cholas. சங்க இலக்கியம், சங்க காலம் மற்றும் சோழர்களின் வெற்றிகள் ஆகியவற்றைக் கற்றுக்கொள்வது.
R19MC101.5	Understand the contribution of Tamils to the Indian freedom struggle and the role of Siddha medicines. இந்திய சுதந்திரப் போராட்டத்தில் தமிழர்களின் பங்களிப்பு, சித்த மருந்துகளின் பங்கு ஆகியவற்றைப் புரிந்து கொள்வது.

R19EM111	Technical Report Writing	L	T	P	C
		1	0	0	NC

1. Course Description

Many professionals have difficulty in expressing ideas on paper which means that useful concepts may never be fully understood or valued. Effective report writing, the exchange of information, views, opinions, and decisions between people at all levels, internally and externally, make a vital contribution to organisational success.This course aims to present a comprehensive overview of the essential elements of effective technical report writing and help delegates develop the practical skills required to write successfully, for an internal or external audience. It will teach the fundamental skills for technical report writing.

2. Course Objectives:

1. Appreciate the importance of technical writing skills necessary in a professional context

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2. Understand the stages in the preparation process of technical reports
3. Demonstrate the ability to pitch technical reports at the level appropriate to the intended audience/reader
4. Identify the essential features of reports, including format, linguistic and grammatical accuracy along with the choice and application of graphics
5. Apply the above principles to the production of effective professional, technical reports

3. Syllabus

- Technical Report writing course will focus on three major themes: researching, writing, and speaking.
- Students will become immersed in the process of inquiry through lecture, reading, and group activities, the goal being to set the foundation for their smooth entry into Research and the completion of independent innovative or industry projects
- Students are instructed to collect minimum 20 technical articles or journals from the reputed publications based on their interesting field in mechanical engineering.
- Consequently, the student must summarize the technical problems, objective of the articles, solution procedures, technology applied to solve the problems and important findings involved in each article.
- Student must organize the collected technical data in the structured format. The report structure must contain suitable title, abstract, introductory section, technical summary of each article, conclusion and references.
- Evaluation is based on originality of the prepared report, structure, PowerPoint preparation and presentation before the evaluation committee members.

Text Books:

1. Lutz Hering., Heike Hering 'How to write technical reports' Springer Publishing,201
2. Daniel G. Riordan 'Technical Report Writing Today' Cengage Learning Publishing, 10th Edition, 2014.

References:

Reference Books:

1. Kenneth G.Budinski, 'Engineers Guide to Technical Writing ASM International, First Edition,2001
2. D.Sudha Rani, 'Advanced Manual for Communication Laboratories and Technical Report Writing' Pearson India Pvt.Ltd.,2012
3. Philip A.Laplante, ' A practical guide for Engineers, Scientists, and Nontechnical Professionals' Second Edition, CRC Press, Taylor` and Francis,2019.
4. Jerome N. Borowick, 'How to Write a Lab Report' Prentice Hall, 2000.
5. Phillip A. Laplante, 'Technical Writing: A Practical Guide for Engineers and Scientists 'CRC Press, Taylor and Francis, 2012.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EM111.1	(Understand) Realize the use of literature analysis
R19EM111.2	(Understand) Become familiar with a variety of journals and online resources and gain an understanding of their value as learning tools
R19EM111.3	(Understand) Understand and utilize the unique style of technical writing
R19EM111.4	(Apply) Prepare annotated bibliographies related to the focus of their project
R19EM111.5	(Apply) Prepare and deliver effective oral presentations for audiences and make effective use of PowerPoint

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SEMESTER III

R19MA204	Probability and Applied Statistics	L	T	P	C
		3	1	0	4

1. Course Description:

This course provides a foundational understanding of probability theory and statistical methods, essential for making informed decisions in diverse fields such as science, engineering, business, and social sciences. The curriculum encompasses both theoretical principles and practical applications, enabling students to analyze data, draw meaningful inferences, and make informed decisions in uncertain situations and develop strategies for implementing effective quality control in diverse industries.

2. Course Objectives:

1. Familiarize the students with outcomes of random occurrences.
2. Enhance them in various distributions and its applications.
3. Inculcate inference about the population on the basis of a random sample.
4. Impart the basic concepts in classification of design of experiments in the field of agriculture.
5. Facilitate the knowledge on control charts and acceptance sampling techniques to ensure quality.

3. Syllabus

Unit-I: Probability

Probability axioms; Conditional probability; Baye's theorem statement only; Discrete and continuous random variables; Moments, moment generating functions.

Unit-II: Standard Distributions

Binomial, poisson, geometric, uniform, exponential, Gaussian distributions.

Unit-III: Testing of Hypothesis

Sampling distributions: Estimation of parameters, statistical hypothesis; Large sample test:single mean, difference of means and Proportion; Small sample tests based on t and F test; Chi-square test for independence of attributes and goodness of fit.

Unit-IV: Analysis of Variance

Introduction, assumptions of analysis of variance; Completely Randomized Design; Randomized
Block Design; Latin Square Design.

Unit-V: Statistical Quality Control

Control charts for measurements (X and R charts); Control charts for attributes (p, c and np charts); Tolerance limits,acceptance sampling,implementation of statistical methods using Excel / R- programming.

Text Books:

1. Walpole R. E., Myers S.L. and Keying Ye, "Probability and Statistics for Engineers and Scientists",9th Edition, Pearson Education Inc, 2012.
2. Johnson R. A., Miller and Freund's, "Probability and Statistics for Engineers", 8th Edition, Pearson Education, Delhi, 2015.

References:

Reference Books:

1. Gupta S. P, "Statistical Methods", Sultan Chand & Sons Publishers, 2014.
2. Veerarajan. T, "Probability, Statistics and Random Processes", 3rd Edition, Tata McGraw Hill, 2009.

Journals:

1. International journal of probability and statistics: http://www.sapub.org/Journal/articles.aspx?journalid=1119 2. International journal of experimental design and process optimisation: https://www.inderscience.com/jhome.php?jcode=ijedpo
Web Resources:
1. https://www.youtube.com/watch?v=KzfWUEJjG18 2. .https://www.youtube.com/watch?v=GwNO0Af1dW8 3. https://www.youtube.com/watch?v=iYiOVISWXS4 4. https://www.youtube.com/watch?v=gI5y3RZe9fk 5. https://www.youtube.com/watch?v=zJ8e_wAWUzE 6. https://www.youtube.com/watch?v=wiYJWyfdGg4 7. https://www.statisticssolutions.com/manova-analysis-anova/ 8. https://www.youtube.com/watch?v=OypCNBPmGBY 9. https://www.youtube.com/watch?v=_V8eKsto3Ug
MOOC/NPTEL/SWAYAM Courses:
1. https://nptel.ac.in/courses/111/105/111105041/ 2. https://nptel.ac.in/courses/111/104/111104089/ 3. https://nptel.ac.in/courses/110/104/110104080/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MA204.1	Apply the basic probability concepts for random variables and random experiments.
R19MA204.2	Apply the probability concepts of one-dimensional random variables for standard distributions which can describe real life phenomena.
R19MA204.3	Apply statistical tests in testing of hypothesis.
R19MA204.4	Apply analysis of variance technique for a given experiment with appropriate situation.
R19MA204.5	Apply quality control theory to examine the standard of the products based on the statistical data.

R19ME201	Engineering Materials and Metallurgy	L	T	P	C
		3	0	0	3

1. Course Description

Explore the fascinating world of materials in this comprehensive course designed to provide a dynamic realm of advanced materials engineering with our comprehensive course. The couse is well designed to provide students with a deep understanding of the principles governing the behavior, processing, and selection of materials, this course offers a holistic approach to mastering the intricacies of modern materials science.

2. Course Objectives:

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1. To give insight in alloy composition's influence on microstructure and properties for informed material selection 2. To develop the knowledge on mechanical properties of materials and strengthening mechanism 3. To familiarize with the properties and applications of ferrous, non-ferrous and advanced engineering materials
3. Syllabus
Unit-I: Constitution of alloys and Phase diagrams
Phases: Gibbs's Phase rule, Solubility and Solid Solutions; Phase diagrams: cooling curves, phase rule, lever rule, binary phase diagrams, Isomorphous, eutectic, eutectoid and peritectic phase diagrams; Iron and iron carbide phase diagram: Invariant reactions, Evolution of Microstructure; Phase transformations: Isothermal transformation diagrams, Continuous cooling transformation diagrams, Applications of phase and transformation diagrams.
Unit-II: Heat treatment and strengthening mechanism
Heat treatment of steels: Annealing, Normalizing, Quench hardening, Tempering, Austempering, Martempering, hardenability and hardenability test using Jominy end Quench; Case hardening: carburising, nitriding, cyaniding, carbonitriding, flame and induction hardening; Strengthening mechanisms: Solid solution strengthening, Dispersion hardening, Precipitation hardening.
Unit-III: Ferrous and non-ferrous metals
Effect of alloying additions: Steel, Stainless steels, Tool steels, HSLA and Maraging steels – Cast Iron: Grey, white, malleable, spheroidal and alloy cast irons; Non - Ferrous Metals: Copper and its alloys, Brass, Bronze and Cupronickel; Aluminium and its alloys: Temper designations for aluminium alloys, Heat treatable and non-heat treatable aluminium alloys; Mg-alloys; Ni-based super alloys and Titanium alloys; Applications of ferrous and non-ferrous metals.
Unit-IV: Non-metallic materials
Polymers: Types of Polymers, Properties and applications of important thermo and thermo setting polymers; Composites: Classification, Processing of composites, Metal Matrix, Ceramic Matrix, polymer matrix composites, Application of composites; Ceramics: Properties and applications of some important Oxide, Carbide and Nitride Ceramics; PSZ and SIALON
Unit-V: Deformation mechanism, mechanical properties and testing
Mechanisms of plastic deformation: slip and twinning; Types of fracture: Basic Mechanical Properties; Testing of materials: Hardness Tests, Brinell, Rockwell and Vickers Hardness test; Tension, compression and shear test; Impact tests: Izod and Charpy Test; - Fatigue tests; Creep test. Computerized Image Processing Techniques – Void and fracture dimensions
Text Books:
1. W.D. Callister, David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th ed., Wiley & Sons, 2013.

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2. Avner, S.H., "Introduction to Physical Metallurgy",2nd Edition, McGraw Hill Book Company, 2013.
References:
Reference Books: 1. O.P.Khanna, "Material Science and Metallurgy", 2nd Edition, Dhanpat Rai Publications, 2014 2. U.C.Jindal : Material Science and Metallurgy, 1st Edition, Dorling Kindersley, 2012 **Videos References:** 1. https://www.youtube.com/playlist?list=PLyAZSyX8Qy5Am_2StOOQ5vCUE3VIcAenE 2. https://www.youtube.com/playlist?list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ **MOOC/NPTEL/SWAYAM Courses:** 1. https://archive.nptel.ac.in/courses/113/102/113102080 2. https://onlinecourses.nptel.ac.in/noc20mm09/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME201.1	Compare different types of solid solutions and phase diagrams in metallurgical systems
R19ME201.2	Apply the knowledge of heat treatments to alter the properties of engineering materials
R19ME201.3	Analyze alloy effects on steel, cast iron, non-ferrous metals, and their applications effectively
R19ME201.4	Develop proficiency in identifying, analyzing, and applying polymer types, composites processing techniques, and ceramics properties
R19ME201.5	Comprehend plastic deformation mechanisms, material testing methods, and computerized image processing techniques to analyze voids and fractures

R19ME202	Manufacturing Technology	L	T	P	C
		3	0	0	3
1. Course Description					
Manufacturing Technology is an interdisciplinary field that encompasses the study of various processes, techniques, and technologies involved in the production of goods. This course provides students with a comprehensive understanding of manufacturing processes, materials, tools, and machinery used in modern manufacturing industries. The course aims to equip students with the knowledge and skills necessary to analyze, design, and optimize manufacturing systems for efficiency, quality, and sustainability. This course introduces students to the fundamental principles and applications of manufacturing technology.					

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Students will gain a comprehensive understanding of the various processes used to transform raw materials into finished products.
2. Course Objectives:
1. To Impart knowledge of fundamental concepts and applications of metal casting, mold preparation with proper gating-riser system, and plastic manufacturing processes. 2. To learn basic principles, effect of process parameters, forming load calculation, formability estimation, and applications of conventional and advanced forming processes. 3. To study basic principles, process parameters, and applications of fusion and solid-state welding processes and design of weld joints 4. To study conventional machining processes, machine tools, and their process capabilities, the influence of process parameters on machining (cutting force, tool wear, and surface finish)
3. Syllabus
Unit-I: Introduction of Manufacturing and Metal Casting Processes
Introduction: Manufacturing process; Sand Casting: Sand Mould, Type of patterns, Pattern Materials, Pattern allowances; Moulding sand: Properties, Testing; Cores: Types, Applications; Gating and riser System; Solidification time Moulding machines– Types; Principle of special casting processes: Shell, investment, Ceramic mould; Pressure die casting; Centrifugal Casting; CO_2 process; Stir casting; Defects in Sand casting; Applications
Unit-II: Joining Processes
Fusion welding processes: Gas welding, Types, Flame characteristics; Manual metal arc welding, Filler, Flux materials; Electrodes: Coated electrode designation for manual metal arc welding; Gas Tungsten arc welding; Gas metal arc welding; Submerged arc welding; Electro slag welding; Resistance welding; Plasma arc welding; Thermit welding; Electron beam welding; Ultrasonic welding; Laser Beam welding; Friction, Friction Stir Welding; Brazing and soldering; Weld defects; Applications
Unit-III: Metal Forming and Sheet Metal Processes
Cold working processes: Blanking, Piercing, Bending, Forming, Rolling; Drawing: Types, wire drawing, Tube drawing, coining, Hot, Cold spinning; Press: Types of presses, Press tools; Basic extrusion processes, Characteristics; Forging processes: Principles of forging, tools, dies, Types of forging, Open, closed, drop forging, roll forging; Special forming processes: Working Principle, Applications; Hydro forming; Rubber pad forming; Metal spinning; Introduction of Explosive forming; magnetic pulse forming; Peen forming; Super Plastic forming; Micro forming; Applications
Unit-IV: Manufacture of Plastic Components
Types and characteristics of plastics; Moulding of thermoplastics: working principles, typical applications; Injection moulding: Plunger, screw machines; Compression moulding; Transfer Moulding; Introduction to blow moulding; Rotational moulding; Film blowing; Extrusion;

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Thermoforming; Calendaring; slush moulding; laminating; Bonding of Thermoplastics; Applications

Unit-V: Machining

Single point cutting tool: nomenclature; Cutting: Orthogonal, oblique cutting; Types of chips; Cutting tool materials; Forces in machining; merchant circle diagram: calculations; Tool wear: Tool life, cutting fluids, Machinability; Principles: Lathe, Capstan, Turret, Shaper, Planer, Slotter, Milling, Drilling, Grinding machine; Applications.

CNC: Basics of NC, CNC machines, Application, Advantages, Manual Part Programming; Super finishing Technology: introduction to Lapping, Horning, Buffing, Barrel Tumbling, Burnishing, Powder coating, Polishing.

Text Books:

1. HajraChouldhary S.K and Hajra Choudhury. AK., "Elements of Workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2014
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013

References:

Reference Books:

1. Rao, P.N. "Manufacturing Technology ", Tata McGraw-Hill Publishing Company Limited, 2008
2. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2015
3. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2009.
4. Groover, "Fundamentals of modern Manufacturing Materials process, and systems", Wiley India Pvt.Ltd., 2007

Journals:

1. Manufacturing Technology Journal - https://journalmt.com/ (Publisher : Elsevier)
2. The International Journal of Advanced Manufacturing Technology - (Publisher - Springer)

Magazines:

1. MT Magazine - https://www.amtonline.org/resources/amtnews
2. Manufacturing Today - https://manufacturing-today.com/

MOOC/NPTEL/SWAYAM Courses:

1. https://www.youtube.com/watch?v=6ISddRRHAhA
2. https://www.youtube.com/watch?v=6ISddRRHAhA&list=PLSGws_74K-1_y_JH5qBvFc-FkFknUILWl
3. https://onlinecourses.nptel.ac.in/noc22_me28/preview
4. https://nptel.ac.in/courses/1121-5127
5. https://in.coursera.org/courses?query=manufacturing%2-process
6. https://www.udemy.com/topic/manufacturing/

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME202.1	Relate different types of patterns, casting process and furnaces used in foundry
R19ME202.2	Distinguish different types of welding process and welding defects
R19ME202.3	Explain forming and sheet metal process based on its applications
R19ME202.4	Explain manufacturing methods of plastic components based on its application
R19ME202.5	Understand the metal cutting principles and various machining processes

R19ME203	Engineering Thermodynamics	L	T	P	C
		3	1	0	4

1. Course Description

Engineering Thermodynamics is a key course that provides learners with the principles and applications of thermodynamics in engineering systems. The course introduces thermodynamic standards and explains how they can be used to analyse and develop diverse engineering processes.

2. Course Objectives:

1. To gain a thorough conceptual understanding of thermodynamic principles and their application to engineering systems.
2. To employ thermodynamic concepts to analyse and solve engineering problems involving energy conversion and use.
3. To educate students on common thermodynamic cycles employed in power generating, refrigeration, and air conditioning systems.
4. To improve critical thinking and problem-solving abilities through practical applications of thermodynamic principles.

3. Syllabus

Unit-I: Basic Concepts and Temperature Relations

Basic concepts: concept of continuum, microscopic, macroscopic approach; Thermodynamic system: Types of systems, Properties, Total and specific quantities, Thermodynamic Equilibrium, State, Path, Process; Quasi-static process: Reversible process, Irreversible process; Work transfer: Definition, comparison, sign-convention, Displacement work, modes of work, P-V diagram; Zeroth law of thermodynamics: concept of temperature, thermal equilibrium, relationship between temperature scales;

Unit-II: First Law Thermodynamics

First law of thermodynamic: Concept of work, Energy, Open, Closed system; Thermodynamic process: Types of processes; SFEE equation: General energy equation, Applications to thermal equipment ;

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Unit-III: Second Law of Thermodynamics
Second law of thermodynamics: Kelvin-Planck, Clausius statements, Heat engines, Heat pump; Reversibility Concepts: Carnot cycle, Carnot theorem, Thermodynamic temperature scale; Third law of thermodynamics: Deduction of the third law of thermodynamics, High, Low-grade energy; Availability and unavailability: Available, Un-available energy of a source; Irreversibility concept: Types of Irreversibility, Applications; Computer based simulation: Design and analyse of Carnot cycle using Learn Chem E Simulator;
Unit-IV: Steam Power Cycles
Rankine cycle: Ideal, Actual cycle, Cycle efficiency, Simple Rankine cycle: Cycle Improvement methods: Superheat, Reheat, Regenerative, Economizer, Air preheater;
Unit-V : Psychometry and Refrigeration System
Psychometry: Properties, Usage of psychometric charts, Property calculations of air vapour mixtures; Refrigeration: Definition, Terminology used, Desirable properties of refrigerant, Classification of refrigerants, Selection of refrigerant, Types of refrigeration systems, Ideal vapour compression refrigeration cycle, Vapour absorption refrigeration cycle; Computer based simulation: Demonstration of Online Interactive Psychometric Chart
Textbooks:
1. Nag. P.K, "Engineering Thermodynamics", 5th Edition, McGraw Hill Education, New Delhi, 2017 2. Yunus. N.J, Cengel. A and Michael Boles. A, "Thermodynamics- An Engineering Approach" 8th Edition, McGraw Hill Education, New Delhi, 2016.
References:
1. Yunus. N.J, Cengel. A and Michael Boles. A, "Thermodynamics- An Engineering Approach" 8th Edition, McGraw Hill Education, New Delhi, 2016. 2. Chattopadhyay, P, "Engineering Thermodynamics", 2nd Edition Oxford University Press, 2016. 3. Rathakrishnan, E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice Hall of India Pvt. Ltd, 2006. 4. Claus Borgnakke and Richard E. Sonntag, "Fundamentals of Thermodynamics", 7th Edition, Wiley Eastern, 2009.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME203.1	(Understand) Familiarize the principles of work and energy
R19ME203.2	(Analyse) Analyse the heat and work transfer in various thermodynamics process
R19ME203.3	(Understand) Acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles

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R19ME203.4	(Apply) Examine the Rankine cycle to determine the efficiency of the steam power systems
R19ME203.5	(Apply)Apply psychometric and refrigeration principles to design and analyse air conditioning and refrigeration systems for various applications.

R19ME251	**Fluid Mechanics and Machinery**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

1. Course Description

Fluid mechanics and machinery courses often involve solving complex problems related to fluid flow, pressure, and machine operation. Engaging with these challenges can enhance your problem-solving skills, a valuable asset in any engineering discipline. Understanding how machines work and the principles behind their operation is essential for engineers involved in the design, maintenance, and optimization of mechanical systems.

2. Course Objectives:

1. Identify and explain the physical properties of fluids, such as density, viscosity, and compressibility, and understand their impact on fluid behavior.
2. Develop analytical and problem-solving skills through the solution of complex fluid mechanics problems, encouraging critical thinking and application of learned concepts.
3. Apply Bernoulli's equation to analyze fluid flow problems, including its application to energy balance in pipes, nozzles, and other flow devices.
4. Apply mathematical models and computational methods to analyze fluid machinery systems, considering factors such as fluid flow, pressure losses, and efficiency.
5. Understand the working principles of pumps and turbines, including their classification, performance characteristics, and applications in various engineering systems.

3. Syllabus

Unit-I: Fluid – Properties, Statics and Dynamics

Fluid – Units and dimensions - Physical Properties of fluids -Fluid Statics- Pascal Law - Pressure Measurements by manometers. Fluid Dynamics - Continuity equation - energy or Bernoulli's equation - Momentum or Euler's Equation.

Computer Application: Introduction to hydraulics and pneumatics simulation

Unit-II: Flow through Pipes

Laminar flow - Reynold's Experiment - Laminar flow through circular conduits - Turbulent Flow - Darcy Weisbach equation - Chezy's Equation - Friction factor and Moody diagram - Losses in Pipe Flow - Major and minor losses - Pipes in series and parallel.

Computer Application: ANSI representation of various fluid power components

Unit-III: Dimensional Analysis And Model Studies

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Similarity Laws - Types of Models.

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Computer Application: Circuit design using fluid power components.
Unit-IV: Pumps
Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies – Velocity triangles - Axial Flow Pump - Reciprocating pump working principle - Indicator diagram and it's variations - Rotary pumps.
Unit-V: Turbines
Turbines - Classification of turbines – Working principles - Pelton wheel - Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines **Total: 45 Hours** **LIST OF EXPERIMENTS** 1. Determination of the Coefficient of discharge of using Orifice meter. 2. Determination of the Coefficient of discharge of using Venturi meter. 3. Calculation of the rate of flow using Rota meter. 4. Determination of major energy loss for a given set of pipes. 5. Conducting experiments and draw the characteristic curves of Centrifugal pump. 6. Conducting experiments and draw the characteristic curves of Submergible pump. 7. Conducting experiments and draw the characteristic curves of Reciprocating pump. 8. Conducting experiments and draw the characteristic curves of Gear pump. 9. Conducting experiments and draw the characteristic curves of Pelton wheel. 10. Conducting experiments and draw the characteristics curves of Kaplan turbine. 11. Conducting experiments and draw the characteristics curves of Francis turbine. **Total: 30- Hours**
Text Books:
1. Y.A.Cengel&J.M.Cimbala, "Fluid Mechanics: Fundamentals and Applications", McGraw Hill Education, 2010. 2. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010. 3. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011 4. White, F.M., "Fluid Mechanics", Tata McGraw Hill, 5th Edition, New Delhi, 2003 5. Kumar K L, "Engineering Fluid Mechanics", S Chand and Company, 2010.
Reference Books:
1. Bansal, R.K., "Fluid Mechanics and Hydraulics Machines", 5th edition, Laxmi Publications Pvt. Ltd, New Delhi, 2008. 2. Modi P.N and Seth " Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House New Delhi. 2003

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME251.1	Analyze energy transfer within fluid systems, applying principles such as Bernoulli's equation
R19ME251.2	Apply principles of fluid dynamics to analyze and predict fluid flow in various engineering systems, including pipes, channels, and open channels.
R19ME251.3	Apply dimensional analysis techniques to analyze and solve engineering problems involving fluid flows.
R19ME251.4	Evaluate the performance of turbines, considering factors such as efficiency, head losses, and power requirements.
R19ME251.5	Analyze the performance of pumps by considering efficiency and operational characteristics.

R19ME211	Computer Aided Machine Drawing Laboratory	L	T	P	C
		0	0	2	1

1. Course Description

A Computer-Aided Machine Drawing Lab is a hands-on learning environment where students can apply computer-aided design (CAD) software to create detailed drawings and models of machine components and systems. The lab typically focuses on teaching students the principles of engineering graphics and design using digital tools. It familiarizes students with popular CAD software tools such as AutoCAD, SolidWorks, or similar applications. It emphasizes the importance of precision and clarity in technical drawings. It provides 3D modelling exercises to enable students to create detailed three-dimensional representations of machine parts and assemblies. Moreover, this course guide student in creating assembly drawings that showcase how different machine components fit together. Finally it emphasize adherence to industry standards for documentation, including drawing layouts, title blocks, and notation.

2. Course Objectives:

1. To create detailed three-dimensional representations of machine parts and assemblies.
2. To introduce concepts such as extrusion, revolve, and Boolean operations for 3D modeling.
3. To guide students in creating assembly drawings that showcase how different machine components fit together.
4. To create detail drawings for industry standards

3. Syllabus

Unit-I: Drawing Standards

Code of practice for Engineering Drawing: BIS specifications, Welding symbols, riveted joints, keys, fasteners; Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc.

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Unit-II: Fits and Tolerances
Tolerancing: Limits, Fits, Specification of Fits; Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning &tolerancing.
Unit-III: Introduction to Drafting Package
Drawing tools: Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing; Bearings: Bush bearing; Plummer block Valves: Safety and non-return valves.
Unit-IV: 3D Geometric Modelling and Assembly
Modelling features: Sketcher, Datum planes, Protrusion, Holes, Part modelling, Extrusion, Revolve, Sweep, Loft, Blend, Fillet, Pattern, Chamfer, Round, Mirror, Section, Assembly • Couplings Flange: Universal, Oldham's, Muff, Gear couplings. • Joints: Knuckle, Gib& cotter, strap, sleeve & cotter joints. • Engine parts: Piston, connecting rod, cross-head (vertical and horizontal), stuffing box, multi-plate clutch. • Miscellaneous machine components: Screw jack, machine vice, tail stock, chuck, vane and gear pump.
Text Books:
1. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013 2. James D Bethune, "Engineering Graphics with AutoCAD 2-17", Pearson Education, 2018.
Reference Books:
1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013 2. Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004 3. N.Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill,2006 4. S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME211.1	(Apply) Acquire the knowledge of various standards and specifications about standard machine components
R19ME211.2	(Apply) Apply the knowledge of fits and tolerances for various applications

R19ME211.3	(Analyze) Model components of their choice using CAD software
R19ME211.4	(Analyze) Sketch Manual drawings of assemblies with the help of given part
R19ME211.5	(Create) Create detailing of a Machine component

R19ME212	**Manufacturing Technology Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

1. Course Description

The Manufacturing Technology Laboratory course is designed to complement theoretical knowledge with hands-on practical experience in various manufacturing processes and techniques. This course provides students with the opportunity to apply concepts learned in the classroom to real-world manufacturing scenarios, thereby enhancing their understanding and proficiency in manufacturing technology. The Manufacturing Technology Laboratory course provides students with valuable hands-on experience and practical skills that are essential for success in the field of manufacturing. Through active participation in laboratory activities, students will develop confidence, critical thinking abilities, and problem-solving skills that are highly sought after by employers in the manufacturing industry.

2. Course Objectives:

1. To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in the industry
2. To practice the various operations that can be performed in lathe, shaper, drilling, milling machines
3. To practice the various operations that can be performed in special purpose machines and other etc. and to equip with the practical knowledge required in the core industries

3.List of Experiments

1. Create the component as per the given diagram using the operations of Turning, Facing, chamfering, step turning, taper turning and knurling
2. Build the component as per the given diagram performing with Turning, Grooving, Thread Cutting (External) operations
3. Create the component as per the given diagram using Turning, Drilling and Eccentric turning operations
4. Build the component as per the given drawing using Turning, Boring and internal thread cutting operations
5. Develop and perform Square & Hexagonal Head Shaping in the Shaping machine as per given drawing
6. Develop and perform the Spur gear hobbing operation as per the given drawing.
7. Machine the workpiece in Surface grinding & Shaft grinding as per the given drawing.
8. Create the tool in the Tool & cutter grinding machine as per the given diagram
9. Build the slot in the given workpiece in Slotting machine as per given diagram
10. Perform the Contour milling using vertical milling machine as per given digaram
11. Design and develop the green sand moulds for the given drawing.
12. Create Welding of butt joints, lap joints, tee joints by using Arc/Gas/TIG Welding as per the given drawing

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13. Design and develop the Rectangular tray or Funnel by using sheet metal operations as per the given drawing 14. Create process plan for given component
Text Books:
1. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2009. 2. Rao, P.N. "Manufacturing Technology " Tata McGraw-Hill Publishing Company Limited, 2008
References:
Reference Books: 1. Hajra Chouldhary S.K and Hajra Choudhury. A K., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2014 2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2013 **Web Resources:** 1. http://vlabs.iitkgp.ac.in/psac/newlabs2-2-/vlabiitkgpAM/ 2. https://www.vlab.co.in/broad-area-mechanical-engineering 3. https://nitkkr.ac.in/?page_id=1317 4. http://mtl.mech.ntua.gr/ 5. https://vignanits.ac.in/production-technology-lab/ 6. http://vlabs.iitkgp.ac.in/psac/newlabs2-2-/vlabiitkgpAM/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME212.1	Machine the work piece as per given drawing using Lathe / shaper / Slotter / Grinder
R19ME212.2	Make gear as per given drawing using gear hobbing
R19ME212.3	Use different moulding tools, patterns to prepare sand moulds.
R19ME212.4	Use fabrication tools to join and fabricate the structures using Welding / Forming / Bending / Carpentry tools
R19ME212.5	Prepare process plan for given component.

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R19EM201	Logical Thinking	L	T	P	C
		0	0	2	1

1. Course Description:

This course aims to help students build strong skills in logical thinking, reasoning and problem-solving. They will learn to analyze and evaluate arguments, spot logical fallacies and create clear and convincing arguments. Through lectures and practical exercises, students will develop the critical thinking needed to tackle engineering problems methodically and precisely. They will also understand the importance of logical thinking in designing and implementing engineering solutions, making them more effective engineers.

2. Course Objectives:

1. Apply logical algorithms to tackle complex problem-solving scenarios.
2. Develop analytical skills for optimizing costs in logical operations.
3. Master time and resource management through logical approaches.
4. Strengthen quantitative reasoning for data-driven decision-making.
5. Enhance logical and visual reasoning to solve intricate problems effectively.

3. Syllabus

Unit-I: Fundamental Skills for Problem Solving

Application of Problem Solving in real life, Different algorithms in problem solving: Brute force approach, Pattern finding method and Deep Learning Approach. Numbers System: Primes and factors, factors and factorials, divisibility rule, unit digit calculation and power cycle method, remainder concepts, HCF and LCM.

Unit-II: Critical Analysis of Cost Management

Fundamentals of Finance: Percentages, Fluctuations in percentage, Profit and Loss, Pricing Logics, Retail Pricing Strategy; Interest calculation: Cash Flow and Taxes; Simple and Compound interest calculation, Puzzle related to interest changes and Case Studies.

Unit-III: Time and Work Management

Fundamentals of Human Resources and Operations: Resources allocation, Time and Work, Puzzle involving backtracking, All possible routes, Pipes and Cisterns.

Unit-IV: Quantitative Reasoning and Data Interpretation

Fundamentals of statistics: Mean, Median and Mode, Real life application of statistics, Application of Ratios and Proportions in business problems, Partnerships; Geometry: 2D, 3D Visualizations.

Unit-V: Logical and Visual Reasoning

Paradigm shift and its application: Syllogism, Cube 3D visualization problems, Blood Relation, Coding decoding: Basics and Advanced. Visual reasoning: Patterns, Paper folding, Case Studies and Puzzles.

References:

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Reference Books:

1. Dr. R S Aggarwal, Quantitative Aptitude, Revised Edition, S.Chand Publishing Company Ltd(s), 2022
2. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, 10th Edition, Tata McGraw-Hill Publishing Company Ltd. 2022

Web Resources:

1. https://www.hackerearth.com/
2. https://www.geeksforgeeks.org/
3. https://www.indiabix.com/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EM201.1	Apply logical algorithms and mathematical methods to solve real-world problems.
R19EM201.2	Analyze and evaluate cost management strategies in various contexts.
R19EM201.3	Apply principles of time management and work efficiency in practical situations.
R19EM201.4	Use quantitative methods and interpret data to make informed decisions.
R19EM201.5	Create solutions to complex logical and visual reasoning problems by applying advanced reasoning techniques

R19MC102	Tamils and Technology / தமிழரும் தொழில்நுட்பமும்	L	T	P	C
		1	0	0	1

1. Course Description:

The intersection of Tamils and technology refers to the field of agricultural technology, focusing on the use of modern tools and techniques to enhance farming practices and increase agricultural productivity.

2. Course Objectives:

1. To increase agricultural productivity and profitability by implementing innovative solutions that optimize resource usage, minimize losses, and enhance crop yields.
2. To automate the irrigation systems to adjust water usage based on real-time data on soil moisture levels, weather forecasts, and crop water requirements.

3. Syllabus:

Unit-I: Weaving and Ceramic Technology / நெசவு மற்றும் பானைத் தொழில்நுட்பம் **(3)**

Weaving Industry during Sangam Age – Ceramic Technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

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Unit-II: Design and Construction Technology / வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்
Designing and Structural construction of Houses & Designs in household materials during the Sangam Age - Building materials and Hero stones of Sangam Age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period. சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் &சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ- சாரோசெனிக் கட்டிடக் கலை
Unit-III: Manufacturing Technology / உற்பத்தித் தொழில் நுட்பம்
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.
Unit-IV: Agriculture and Irrigation Technology / வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society. அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு- மீன்வளம் முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

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Unit-V: Scientific Tamil and Tamil Computing /அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project. அறிவியல் தமிழின் வளர்ச்சி -கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம்- தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.	
Text Books:	
1. தமிழக வரலாறு மக்களும் பண்பாடும் கே.கே.பிள்ளை (வெளியீடு - தமிழ்நாடு பாடநூல் மற்றும்கல்வியியல் பணிகள் கழகம்). 2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்). 3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு). 4. பொருநை - ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு). 5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print) 6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies. 7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies). 8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.) 9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author) 11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu) 12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.	
References:	
Reference Books: 1. Journey of Civilization Indus to Vaigai - R. Balakrishnan, Published by: RMRL. 2. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).	

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4. Course Outcomes/ பாடநெறி முடிவுகள்:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome / பாடநெறி முடிவுகள்
R19MC102.1	Describe about the weaving industry in sangam age and ceramic technology. சங்க காலத்தில் நெசவுத் தொழில் மற்றும் பீங்கான் தொழில்நுட்பம் பற்றி விரிவாக அறிந்து கொள்ளுதல்.
R19MC102.2	Observe the design of houses, sculptures and construction of temples. வீடுகளின் வடிவமைப்பு, சிற்பங்கள் மற்றும் கோவில்களின் கட்டுமானத்தைப் பற்றி தெரிந்து கொள்ளுதல்.
R19MC102.3	Relate the various manufacturing materials and stone types in Silappathikaram. சிலப்பதிகாரத்தில் உள்ள பல்வேறு உற்பத்திப் பொருட்கள் மற்றும் கல் வகைகளைப் பற்றி புரிந்து கொள்ளுதல்.
R19MC102.4	Understand the significance of agriculture and irrigation technology in the ancient period. பண்டைய காலத்தில் விவசாயம் மற்றும் நீர்ப்பாசன தொழில்நுட்பத்தின் முக்கியத்துவத்தை புரிந்து கொள்ளுதல்.
R19MC102.5	Explain the growth of scientific Tamil, Tamil computing and the digitization of Tamil books. அறிவியல் தமிழின் வளர்ச்சி, தமிழ்க் கணினி, தமிழ் நூல்களின் டிஜிட்டல் மயமாக்கல் ஆகியவற்றை விரிவாக தெரிந்து கொள்ளுதல்.

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SEMESTER IV

R19MA207	Numerical Methods and Partial Differential Equations	L	T	P	C
		3	1	0	4

1. Course Description

Numerical methods provide approximate solution, mainly useful in cases where the exact solution is impossible or prohibitively expensive to calculate. It provides solutions to real-life problems from the field of science, engineering, biology, astrophysics and finance. Partial differential equations (PDE) develop students' skills in the formulation, solution, understanding and interpretation of models and developing analytic solutions in modern science and engineering. PDE is effectively used to simulate a wide range of phenomena, such as resolving wave and heat flow equations.

2. Course Objectives:

1. Enhance the knowledge of algebraic and transcendental equations and to find the dominant eigenvalue of a matrix.
2. Introduce the numerical techniques of interpolation, differentiation and integration.
3. Introduce the initial value problems by single and multistep methods numerically.
4. Impart the knowledge to formulate and solve the partial differential equations using
5. various techniques.
6. Acquaint the knowledge of partial differential equations using various numerical techniques.

3. Syllabus

Unit-I: Solution of Equations and Eigen Value Problems

Solution of algebraic and transcendental equations: Newton Raphson method, Solution of system of linear equations: Gauss- Jordan method, Gauss-Seidel method; Eigen values of a matrix by power method.

Unit-II: Interpolation, Numerical Differentiation and Integration

Interpolation: Lagrange's interpolation, Newton's forward interpolation, Newton's backward interpolation; Numerical differentiation: Newton's forward formula, Newton's backward interpolation formula; Numerical integration for a single variable: Trapezoidal rule, Simpson's one third rule.

Unit-III: Initial Value Problems for Ordinary Differential Equations

Single step methods: Taylor series method, Euler's method, Modified Euler's method, Fourth order Runge-Kutta method; Multistep methods: Milne's predictor and corrector method, Adam's predictor and corrector method.

Unit-IV: Partial Differential Equations

Solutions of partial differential equations: Standard types, Lagrange's linear equation of first- order equations, Homogeneous linear equations for second and higher order with constant coefficients.

Unit-V: Boundary Value Problems in Partial Differential Equations

Solution of two-dimensional Laplace and Poisson equations by finite difference techniques; One dimensional heat flow equation by explicit and implicit methods; One dimensional wave equation by explicit method.

Text Books:

1. Burden R. L and Douglas Faires J, "Numerical Analysis Theory and Applications", Cengage Learning, 9th Edition, 2010.
2. Grewal B. S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi,2015.

References:

Reference Books:
1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 7th Edition, Tata McGraw-Hill, New Delhi, 2016. 2. Gerald C. F and Wheatley P.O, "Applied Numerical Analysis", 7th Edition, Pearson Education, New Delhi, 2015. 3. Veerarajan T, "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd, New Delhi, Second reprint, 2015.
Journals:
1. International Journal for Numerical Methods in Fluids: https://www.scimagojr.com/journalsearch.php?q=18534&tip=sid&clean=0 2. Journal of Applied and Numerical Optimization: https://www.scimagojr.com/journalsearch.php?q=21101045272&tip=sid&clean=0 3. International Journal for Numerical Methods in Engineering: https://scirev.org/journal/international-journal-for-numerical-methods-in- engineering/ 4. An international journal numerical Methods for Partial Differential Equations : https://www.emeraldgrouppublishing.com/journal/hff
Web Resources:
1. www.nm.mathforcollege.com/videos 2. https://cosmolearning.org/courses/numerical-methods-and-programing/video-lectures/ 3. https://www.youtube.com/watch?v=oE98W4A7Zio 4. www.learnerstv.com/Free-Maths-Video-lectures-ltv696 5. https://www.youtube.com/watch?v=_V8eKsto3Ug
MOOC/NPTEL/SWAYAM Courses:
1. https://mat.iitm.ac.in/home/sryedida/publichtml/caimna/interpolation/lagrange.html 2. https://ocw.mit.edu/.../18...equations.../probwave1solns.pdf 3. https://nptel.ac.in/courses/Webcourse-contents/IISc-BANG/...--/Numerical%20 Analysis.pdf

4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MA207.1	Apply the numerical techniques to obtain approximate solutions for algebraic, transcendental and system of linear equations.
R19MA207.2	Apply numerical methods to solve integration and differentiation problems and interpolate the data.
R19MA207.3	Evaluate the initial value problem using numerical techniques for engineering applications.
R19MA207.4	Apply the mathematical principles to solve partial differential equations.
R19MA207.5	Analyze and solve the partial differential equations with initial and boundary conditions using various numerical approaches.

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R19ME206	Kinematics of Machinery	L	T	P	C
		3	0	0	3

1. Course Description

Kinematics of Machines discusses the relative motion of various elements in a machine. The course describes how the structural design of a mechanical system can be optimized to produce a desired motion of its elements and achieve better performance.

2. Course Objectives:

1. Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, planar mechanisms
2. Analyze the planar four bar and slider crank mechanisms for position, velocity and acceleration
3. Analyze cams and followers for specified motion profiles
4. Analyse gear tooth geometry and select appropriate gears for the required applications
5. Analyze friction drives for the given specifications

3. Syllabus

Module-I: Fundamentals of Mechanisms

Basic Terminology: Kinematic link, Pair, joints, Degree of freedom; Kinematic chain; Structure, Machine; Mobility of mechanisms: Grubler criterion, Kutzbach Criterion; Four bar mechanism: Mechanical advantage, Transmission angle; Inversions: Slider-crank chain, Double slider-crank chain.

Computer Aided Simulation: Mechanisms simulation

Module-II: Kinematic Analysis of Mechanisms

Relative Velocity Method: Relative velocity of kinematic link; Rubbing Velocity of kinematic pair; Coriolis component of acceleration; Construction of velocity, acceleration diagram: Four bar mechanism, slider crank mechanisms and complex mechanisms

Module-III: Cam and Follower Mechanisms

Cam: Introduction, Terminology, Classifications; Types of follower motion: Uniform velocity Motion, Simple Harmonic Motion, Uniform Acceleration and Retardation Motion, Cycloidal Motion; Construction of cam profile: Knife edge follower, Roller follower, flat faced follower.

Computer Aided Simulation: Rotating Cam, Follower simulation

Module-IV: Gears and Gear Trains

Gears: Classifications, Terminology, Law of gearing, Velocity of Sliding, Length of path of contact, Length of arc of contact, contact ratio, Speed ratio, Train value; Gear trains: Simple gear train, Compound gear train, Epicyclic gear train,

Computer Aided Simulation: Different Gear Train simulation

Module-V: Friction Drives

Friction: Definition, Types; Laws of friction; Friction clutch: single plate and Multi plate clutch; Flat Belt Drives: Open, Cross belt drive, Velocity ratio, slip, Law of belting, length of belt, Ratio of friction tension, Power transmitted, Centrifugal effect, creep; V Belt drive: Velocity ratio, length of belt, Ratio of friction tension, Power transmitted, Centrifugal effect, creep

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Text Books:
1. S.S Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2014 2. R.S Khurmi," Theory of Machines",16th Edition, S Chand Publications, 2017
Reference Books:
1. Sadhu Singh, Theory of Machines, Second Edition, Pearson Education, 2012. 2. F.B. Sayyad, "Kinematics of Machinery", MacMillan Publishers Pvt Ltd., Tech-max educational resources, 2011 3. J. J. Uicker, G. R. Pennock and J. E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, New York, 2011

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME206.1	(Apply) Identify the simple mechanisms based on the given applications
R19ME206.2	(Apply) Find velocity and acceleration of simple mechanisms
R19ME206.3	(Analyze) Construct the cam profile for different types of follower motion.
R19ME206.4	(Apply) Identify the kinematic terminologies of spur gear and calculate speed ratio of various types of gear train
R19ME206.5	(Analyze) Estimate the amount of power transmitted by friction drives

R19ME207	Thermal Engineering	L	T	P	C
		3	1	0	4

1. Course Description

Thermal engineering focuses on the transfer of heat, fluid mechanics, and heating and cooling systems, such as those used in the electric power industry, the automobile industry and the heating, ventilation and air conditioning (HVAC) industry. Thermal engineering breaks down into numerous specialized fields where thermal engineers may work, including: Heat transfer and thermal power, Thermal system design, Combustion engineering, Thermal science and energy systems, Refrigeration and air conditioning, Hydro-turbomachines and thermal turbomachines and Internal combustion engines. Thermal engineers design systems that utilize various thermal sources of generated energy to create chemical, mechanical or electrical energy. They must have an understanding of thermodynamics, fluid mechanics and heat and mass transfer.

2. Course Objectives:

1. To prepare students to excel in research or to succeed in Thermal engineering profession through global, rigorous post graduate education.
2. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve thermal engineering problems.
3. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design and create novel products and solutions for the real life problems.

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4. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach and an ability to relate thermal engineering issues to broader social context.
5. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines and the life-long learning needed for a successful professional career.

3. Syllabus

Unit-I: Gas Power Cycles

Air Standard Cycles: otto cycle, diesel cycle, dual cycle, applications, cycle Analysis; Air standard efficiency; Mean Effective Pressure; Comparison: otto cycle, diesel cycle, dual cycle; Brayton cycle analysis: open cycle, closed cycle, Applications.

Unit-II: Air Compressors

Reciprocating air compressor: classification, working principle, Work of compression; with and without clearance, Efficiency: isothermal efficiency, isentropic efficiency, volumetric efficiency, Multistage air compressor: intercooler; Rotary air compressor: classification, working principle, Centrifugal and axial flow compressors; applications.

Computer Aided Simulation: Simulation of compressor operations (Not For Examination)

Unit-III: Internal Combustion Engines and Combustion

IC engine: classification, working, components, functions, Valve and port timing diagrams: Ideal, actual, P-v diagrams: two stroke, four stroke, SI& CI engines: comparison; geometric, operations, performance, comparison, Desirable properties; Qualities of fuels; Air-fuel ratio; lean and rich mixtures; Combustion: SI, CI Engines, Knocking: phenomena, factors, control.

Unit-IV: Internal Combustion Engine Performance and Systems

Performance and heat balance: 4 stroke, 2 stroke; Morse test; Multipoint fuel Injection system; Common rail direct injection systems; Ignition systems: magneto, battery, Electronic system, Lubrication; Cooling systems; Supercharging; Turbocharging; Emission norms.

Unit-V: Steam Nozzle and Steam Turbines

Nozzles: types, shaps, Flow pattern; Critical pressure ratio; Mass flow; Pressure ratio; Effect of friction; Metastable flow; Impulse, reaction turbine: principles, velocity diagrams, work done, efficiency; Optimal operating conditions; Multi-staging; compounding, governing.

Computer Aided Simulation: Simulation of velocity and pressure variations (Not For Examination)

Text Books:

1. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., “A course in Thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2012.
2. Er.Rajput. R. K., “Thermal Engineering”, tenth Edition, Lakshmi publication, 2015.

References:

1. Ramalingam.K.K., “Thermal Engineering”, First Edition, Scitech publication (Ind) (p) LTD,2015.
2. Ganesan. V “Internal Combustion Engines” , Fourth Edition, Tata Mcgraw-Hill 2016
3. Sarkar. B.K,”Thermal Engineering”, First Edition, Tata McGraw-Hill Publishers, 2011
4. Rudramoorthy, R, “Thermal Engineering “, First Edition, Tata McGraw-Hill, New Delhi,2010

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME207.1	(Apply) Apply the concept of air standard cycle and use the relation to arrive the air standard efficiency and mean effective pressure
R19ME207.2	(Apply) Design and Development of work of compression for multistage compressor. Evaluate the isothermal, isentropic and volumetric efficiency with and without intercoolers
R19ME207.3	(Analyze) Study on the performance of two stroke and four stroke IC engines, and evaluate the factors affecting combustion and knocking in petrol and diesel engine
R19ME207.4	(Analyze) Experimental investigation on the performance of four stroke petrol and diesel engine and prepare the heat balance sheet in order to evaluate the percentage of useful power
R19ME207.5	(Analyze) Understand the concepts of flow pattern of Steam Nozzle and construct the velocity diagrams for steam turbines

R19EC352	Embedded Systems And IOT	L	T	P	C
		3	0	2	4

1. Course Description:

This course empowers you to unlock the potential of the Internet of Things (IoT) by diving into the core technologies driving smart devices. Gain a solid understanding of embedded system architecture and development processes, learn how to design and connect embedded hardware within the IoT landscape, and explore the powerful integration with cloud computing and GSM interfaces. By the end, you'll be equipped to develop and build your own simple IoT applications.

2. Course Objectives:

1. To facilitate Understanding of Embedded System Architecture
2. To guide Students Through the Embedded Systems Development Process and AI Integration
3. To instruct on IoT Architecture and Embedded Hardware Design
4. To explain Cloud Computing Concepts and GSM Interface
5. To guide the Development of Products for Simple IoT Applications

3. Syllabus:

Unit-I: Embedded System Architecture

Introduction to Embedded systems; application areas; categories; overview; specialities; recent trends; hardware architecture; software architecture; application software; communication software; Embedded System Lifecycle; process of generating executable image; developing and testing tools; Market available freeware for Embedded Systems development.

Unit-II: Embedded System Development

Development process: requirements engineering, design, implementation, integration and testing; Architecture of Kernel; Tasks and task scheduler; Interrupt service routines;

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1. IEEE Transactions on Embedded Systems
2. Journal of Embedded Computing

Magazines:

1. https://www.embedded.com/
2. https://www.iotworldtoday.com/

Web Resources:

1. https://www.arduino.cc/
2. https://www.raspberrypi.org/

MOOC / NPTEL / SWAYAM Courses:

1. https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs53/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC352.1	Analyze and synthesize the architecture of Embedded Systems, delineating its constituent components.
R19EC352.2	Utilize conceptual understanding to apply the design process of Embedded Systems
R19EC352.3	Apply advanced cognitive skills to conceptualize the architecture of IoT systems and develop basic applications employing embedded hardware.
R19EC352.4	Apply higher-order cognitive abilities to implement Cloud services in IoT applications
R19EC352.5	Generate innovative solutions by integrating NodeMCU and Raspberry Pi boards to design IoT applications

R19ME252	Strength of Materials	L	T	P	C
		3	0	2	4

1. Course Description:

The Strength of Materials course provides a fundamental understanding of the behaviour of materials under various loads and deformations. Through comprehensive exploration, students understands the principles of stress, strain, and deformation of materials for various engineering applications.

2. Course Objectives:

1. Equip students to understand and apply fundamental concepts in mechanics of materials, including stress, strain, principal stresses, and principal planes, to Analyze and solve practical problems.
2. Enable students to calculate and Analyze shearing forces and bending moments in determinate beams with external loads.

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semaphores; mailboxes; timers; memory management; valgrind for memory analysis priority inversion problem; Debugging Tools for Embedded Systems; Introduction to Embedded AI, Edge AI and role of Tiny ML in embedded systems.
Unit-III: IOT Architecture and Embedded Hardware
IoT Evolution and Applications; IoT Application development stages; Microcontrollers used in IoT; Arduino IDE and exploration; Basics of Arduino Programming; PWM signalling in Arduino; Interfacing Sensors: IR sensor; Potentiometer with Arduino; Interfacing Servo motor with Arduino; Introduction to Bluetooth Technology; Interfacing HC-05 and Arduino; Introduction to Arduino Mega, Due; Interfacing of Accelerometer and Colour Sensor; Interfacing Gyroscope with Arduino Uno.
Unit-IV: GSM, Cloud Computing and IoT
Introduction to GSM; Interfacing GSM with Arduino Uno; Calling; Messaging using GSM; Controlling an LED using GSM; Introduction to Cloud Computing; Challenges in Cloud Computing; Data protocols in IoT; Cloud types; Cloud architecture: Infrastructure, platforms, communication protocols and applications; Cloud Services: IaaS, PaaS, SaaS; Understanding Adafruit; Communicating with Cloud.
Unit-V: Product Building and Miniaturization
NodeMCU in a nutshell; ESP32 in a nutshell; Attiny85 in a Nutshell; Programming Attiny85 with Arduino Uno; Interfacing Gyro; Bluetooth with Attiny85; General Voltage Regulation Techniques for IoT; Raspberry Pi in a NutShell; Headless Setup of Raspberry Pi; Video Surveillance using Raspberry Pi; Realtime projects with IoT; Accident Impact Detection; Driver Drowsiness Detection System; Advanced Driver Assist System.
List of Experiments:
Prelims: a. Interfacing Arduino with - Pot, Servo motor, IR Sensor, Stepper Motor, and other Analog/Digital sensors. **Core projects:** 1. Displaying Text/Images using OLED 2. Controlling an LED using WebPage - With NodeMCU 3. Fire Accident Detection Project using MQ135 & LM35. Generating Alert using GSM 4. Logistics tracker using NodeMCU and GPS 5. Interfacing Gyro, Bluetooth with Attiny85 6. Interfacing Ultrasonic sensor and other sensors with Raspberry Pi
Text Books:
1. Embedded Systems- Architecture, Programming And Design | Third Edition - Rajkamal McGraw-Hill 2015 (Unit–I, II) 2. https://www.routledge.com/Lets-Get-IoT-fied-30-IoT-Projects-for-All-Levels/Juluru-Vasudevan-Murugesh/p/book/9780367706074 (Unit III, IV (Half)) 3. Internet of Things, 2ed, Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, ISBN: 9789388991018, Wiley India. (Unit IV, V)
Reference Books:
1. Shibu K.V., "Introduction To Embedded Systems", MGH, 2nd edition, 2017 2. Perry Xiao, "Designing Embedded Systems and the Internet of Things (IoT) with the ARM Mbed", Wiley, 2018
Journals:

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3. Equip students with the knowledge to calculate stresses and deformation in circular shafts and helical springs under torsion, and apply this understanding to real-world problems.
4. Develop students' skills in computing slopes and deflections in determinate beams using various methods, to enhance their analytical and problem-solving abilities.
5. Prepare students to Analyze complex structural components, such as pressure vessels, pipes, and cylinders, by understanding the underlying principles of stress and deformation.

3. Syllabus

Unit-I: Stress, Strain and Deformation of Solids

Rigid bodies and deformable solids; Tension, Compression and Shear Stresses; Theories of Failure; Deformation of simple and compound bars; Thermal stresses; Elastic constants; Volumetric strains; Stresses on inclined planes: principal stresses and principal planes; Mohr's circle of stress.

Computer Aided Simulation (for demonstration Only): Stress, Strain analysis in simple plates, bars

Unit-II: Transverse Loading on Beams and Stresses in Beam

Beams: types; transverse loading on beams; Shear force and bending moment in beams: Cantilevers, simply supported beams and over hanging beams; Theory of simple bending; bending stress distribution; Load carrying capacity; Proportioning of sections; Flitched beams; Shear stress distribution.

Computer Aided Simulation (Not For Examination): Bending stress analysis for different type's beams, supports and load

Unit-III: Torsion & Springs

Torsion formulation stresses and deformation in circular and hollows shafts; Stepped shafts; Deflection in shafts fixed at the both ends; Stresses and Deflection in helical springs, Laminated Leaf springs.

Unit-IV: Deflection of Beams

Computation of slopes and deflections in beams: Double Integration method, Macaulay's method, Area moment method, Conjugate beam; Strain energy; Maxwell's reciprocal theorems.

Computer Aided Simulation (Not For Examination): Simulation of beams subjected to transverse load

Unit-V: Columns and Cylinders

Euler's column theory; critical load for prismatic columns with different end conditions; Effective length; limitations; Rankine-Gordon formula; Eccentrically loaded columns; middle third rule; core of a section; Thin cylindrical and spherical shells; stresses and change in dimensions; thick cylinders; Compound cylinders; shrinking on stresses.

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Computer Aided Simulation (Not For Examination): Buckling load simulation for columns

List of Experiments: **30 Periods**

1. Conduct a tensile test to observe and plot stress-strain behaviour of given specimen under load. Discuss.
2. Conduct an experiment to calculate the ultimate shear strength of the given specimen under double shear load. Discuss.
3. Perform the hardness test to identify the indentation diameter and height on the given specimens with Brinell and Rockwell hardness setup.
4. Conduct the suitable test to determine the toughness of the given specimen by applying sudden load in izod and charpy test.
5. Effect of hardening- Improvement in hardness and impact resistance of steels.
6. Tempering - Improvement Mechanical properties – Comparison (i) Unhardened specimen (ii) Quenched Specimen and (iii) Quenched and tempered specimen
7. Calculate the section modulus of the simply supported beam to compute the bending stress and young's modulus for the given specimen.
8. Torsion test on circular shaft –compute the shear stress and modulus of rigidity
9. Tests on springs – compression - load deformation characteristics, stiffness, shear stress, Shear Modulus, energyStrain measurement using Rosette Strain Gauge.

Text Books:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2017
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007
3. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand& company Ltd., New Delhi, 7th edition, 2018.
4. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

References:

Reference Books:

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2001
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2007.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.

Web Resource:

1. www.forum.jntuworld.com

Video References:

1. https://www.youtube.com/nptel/som
2. https://www.youtube.com/nptel/iitm

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3. www.freevideolectures.com/courses/2361/som/
4. www.youtube.com/watch?v=GKFgysZC4VC

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME252.1	(Create) Create Stress- Strain model for any Mechanical Component
R19ME252.2	(Apply) Apply the fundamental principles to estimate bending stress and shear stress at various points in beams
R19ME252.3	(Analyze) Analyze stress and deformation induced in circular shafts due to torsion
R19ME252.4	(Apply) Calculate slope and deflection in beams using different methods.
R19ME252.5	(Analyze) Analyze stresses and deformation of columns and thin shells for applied pressures.

R19ME281	Project With Design Thinking (Product/Software Development Lifecycle)	L	T	P	C
		0	0	2	1

1. Course Description

Design Thinking for Innovative Projects is an immersive, hands-on course that teaches students a human-centered approach to problem-solving. Students will empathize with end-users to identify and define problems, use tools to gain insights, and engage in creative brainstorming to generate ideas. They will evaluate solutions based on feasibility, desirability, and viability, transform ideas into prototypes, and iterate based on feedback. Working in interdisciplinary teams, students will apply design thinking to real-world projects, progressing from technology formulation (TRL 2) to scalable prototypes (TRL 5), creating solutions aligned with the UN's Sustainable Development Goals (SDGs).

2. Course Objectives:

1. Develop the ability to empathize with end-users to identify and define complex problems.
2. Apply empathy tools and techniques to gain a deep understanding of user needs and pain points.
3. Evaluate and prioritize ideas based on criteria such as feasibility, desirability, and viability.
4. Create prototypes to materialize and test design concepts.
5. Validate design solutions through user testing and feedback.

3. Syllabus

The student identifies the problems in mechanical engineering field by literature or industry survey. After that, the student find the solution to solve that problems by applying modern engineering tools. After finding the solution, the student develops the working model/design/simulation for evaluation. Each student shall finally submit a report covering background information, literature survey, problem

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statement, methodology and use of modern tools within stipulated date. Every project work must be guided by the institute faculty members.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME281.1	Evaluate and select ideas based on criteria such as feasibility, desirability, and viability.
R19ME281.2	Conduct iterative testing to gather feedback and refine prototypes based on user input.
R19ME281.3	Apply critical thinking skills to analyze complex problems and identify innovative solutions.
R19ME281.4	Create visual and verbal representations to communicate design concepts.
R19ME281.5	Develop a reflective mind set to assess the effectiveness of the design thinking process.

R19EM202	Advanced Logical Thinking	L	T	P	C
		0	0	2	1

1. Course Description:

This course aims to develop student's logical thinking skills to an advanced level. Students will explore various techniques and strategies to analyse, evaluate, and synthesize information effectively. Analyzing a situation or problem using a logical approach involves gathering all available information, assessing the facts and efficiently deciding the best course of action. Students strive to understand various topics deeply, enhance their memory skills and build greater understanding. They also apply their ideas effectively and thoroughly analyze any arising issues.

2. Course Objectives:

1. Enhance Critical thinking skills by solving programming logic problems involving permutations and combinations.
2. Enhance the Decision making skills using different Possibilities through Probability
3. To develop the skills to analyze complex problems in Simple Solutions through Time Speed Distance Concept
4. Enhance the strategic thinking for Solving Real life problems using Mathematical Concepts
5. Reinforce the Logical skills through Reasoning Puzzles

3. Syllabus:

Unit-I: Inductive Reasoning through Permutations & Combination

Fundamental Principles of Counting: Permutations & Combination, Number Generation Fundamentals; Digit repeater concepts: All possible ways; Recursion and Backtracking: N step Problems, Chess oriented problems and Case Studies.

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Unit-II: Decision Making based on Probability
Introduction to Probabilities, Application of Probability; Power of Compounding: Case Studies.
Unit-III: Strategical techniques in Time, Speed and Distance
Definition and Basics of Time, Speed and Distance; Relative speed: Problems based on Trains; Effective Speed: Problems based on Boats and Streams; Problems based on Races, Escalator problems; Case Studies.
Unit-IV: The Logical Approach to Mixture and Allegation
Introduction to Mixtures: Multi variable mixing, Profit and Loss concept based on mixing; Liquid mixing concepts: Replacement problems and Repetitive iteration problems.
Unit-V: Logical Reasoning
Introduction to design of clocks; Formula creation: Speed clock and Slow clock problems; Angle calculation; Calendars design: Concept of odd days, Day of a date and Calendar repetition logic; Data Arrangements; Data Sufficiency; Directions; Number series and Puzzles.
References:
Reference Books: 1. Dr. R S Aggarwal, Quantitative Aptitude, Revised Edition, S.Chand Publishing Company Ltd(s), 2022 2. Arun Sharma, How to prepare for Quantitative Aptitude for the CAT, 10th Edition, Tata McGraw-Hill Publishing Company Ltd, 2022 **Web Resources:** 1. https://www.hackerearth.com/ 2. https://www.geeksforgeeks.org/ 3. https://www.indiabix.com/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EM202.1	Develop the ability to use inductive reasoning to solve complex problems involving permutations and combinations.
R19EM202.2	Understand probability theory to make informed decisions under uncertainty.
R19EM202.3	Utilize strategic techniques to solve problems related to time, speed, and distance.
R19EM202.4	Apply logical reasoning to solve problems involving mixtures and allegations.
R19EM202.5	Enhance logical reasoning skills to tackle a variety of analytical problems.

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R19EM203	Summer Internship	L	T	P	C
		-	-	-	NC

1. Course Description

"Summer Internship" provides students with the opportunity to gain practical work experience in a professional setting during the summer months. Through supervised placements in various industries, students will apply theoretical knowledge acquired in their academic studies to real-world scenarios. The internship aims to enhance students' professional skills, expand their networks, and foster personal and career development. Under the guidance of experienced mentors, interns will engage in hands-on projects, tasks, and responsibilities tailored to their academic background and career interests. Through reflection, feedback, and evaluation, interns will refine their skills, gain valuable insights into industry practices, and make meaningful contributions to their host organizations.

2. Course Objectives:

1. Gain hands-on experience in a professional work environment relevant to the student's field of study or career goals.
2. Develop and apply practical skills and knowledge learned in academic coursework to real-world projects and tasks.
3. Network with professionals in the industry to explore career opportunities and build professional relationships.
4. Receive mentorship and guidance from experienced professionals to support personal and professional growth.
5. Reflect on internship experiences to identify strengths, areas for improvement, and future career goals.

3.Syllabus:

To undergo Internship for two weeks in relevant field of study

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EM203.1	Demonstrate an understanding of industry-specific practices, procedures, and terminology through immersion in a professional work environment
R19EM203.2	Interpret and explain the relevance of theoretical concepts learned in academic coursework to practical tasks and projects encountered during the internship
R19EM203.3	Apply acquired knowledge and skills to solve real-world problems, contribute to projects, and complete assigned tasks effectively within the internship setting

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R19EM203.4	Analyze and evaluate their internship experiences, reflecting on challenges faced, solutions implemented, and lessons learned to assess their own growth and development.
R19EM203.5	Synthesize their internship experiences, integrating knowledge gained from various sources, including academic coursework, mentorship, and practical application, to formulate strategies for future career development and success.

R19MC202	**Indian Constitution and Tradition**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**NC**

1. Course Description

This course provides a comprehensive exploration of the Indian Constitution and Tradition, with a primary focus on understanding its historical evolution, guiding principles, organizational framework, and contemporary relevance. Students will delve into the intricate layers of India's constitutional legacy, examining the multifaceted influences of democratic governance.

2. Course Objectives:

1. Understand the foundational principles and historical context of the Indian Constitution and tradition.
2. Explore the role of tradition in shaping contemporary Indian constitutional law and governance.
3. Assess the interplay between constitutional amendments and traditional values in Indian society.
4. Critically reflect on the relevance and adaptability of Indian constitutional principles in a modern context.
5. Examine the evolution of constitutional rights and duties within the framework of Indian tradition.

3. Syllabus:

Unit-I: History of Indian Constitution

Meaning of the constitution law and constitutionalism - Historical perspective of the Constitution of India, Salient features and characteristics of the Constitution of India

Unit-II: Fundamental Rights and Duties

Scheme of the fundamental rights - Fundamental Duties and its legal status - Directive Principles of State Policy, Its importance and implementation

Unit-III: Federal Structure and Distribution of Powers

Federal structure and distribution of legislative and financial powers between the Union and the States - Parliamentary Form of Government in India - The constitution powers and status of the President of India - Amendment of the Constitutional Powers and Procedure

Unit-IV: Constitutional Amendments And Emergency Provisions

The historical perspectives of the constitutional amendments in India - Emergency Provisions: National Emergency, President Rule, Financial Emergency - Local Self Government - Constitutional Scheme in India

Unit-V: Right To Equality, Freedom, And Personal Liberty

Scheme of the Fundamental Right to Equality - Scheme of the Fundamental Right to certain Freedom under Article 19 - Scope of the Right to Life and Personal Liberty under Article 21

Text Books:

1. Sunil Khilnani, "The Idea of India", Penguin India Ltd., New Delhi.
2. Madhav Khosla, "The Indian Constitution", Oxford University Press, New Delhi, 2012.

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References:
Reference Books: 1. Brij Kishore Sharma, "Introduction to the Indian Constitution", PHI, New Delhi 2. Sumantra Bose, "Transforming India: Challenges to the World's Largest Democracy", Picador India, 2013. 3. Atul Kohli, "Democracy and Discontent: India's Growing Crisis of Governability", Cambridge University Press, Cambridge, U. K., 1991. 4. M. P. Singh and Rekha Saxena, "Indian Politics: Contemporary Issues and Concerns", PHI, New Delhi, 2008, latest edition. 5. Rajni Kothari, "Rethinking Democracy", Orient Longman, New Delhi, 2005. **Video References:** 1. https://www.youtube.com/watch?v=JrqpQvRQft0 2. https://www.youtube.com/watch?v=XrKEtEzqZ7g 3. https://www.youtube.com/watch?v=9yaf5TFp-DE **Web Resources:** 1. https://en.wikipedia.org/wiki/Constitution_of_India 2. https://www.india.gov.in/my-government/constitution-india 3. https://byjus.com/free-ias-prep/sources-of-indian-constitution/ 4. https://academic.oup.com/past/advance-article/doi/10.1093/pastj/gtad009/7147824 5. https://www.vifindia.org/article/2017/august/03/indian-civilisation-and-the-constitution 6. https://search.worldcat.org/title/constitution-of-india-a-contextual-analysis/oclc/1002722580 7. https://main.sci.gov.in/constitution **MOOC/SWAYAM/NPTEL Courses:** 1. https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-lw03/ 2. https://archive.nptel.ac.in/courses/129106002/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MC202.1	Understand the characteristics of the Constitution of India.
R19MC202.2	Understand the fundamental rights and duties.
R19MC202.3	Understand the federal structure and distribution of legislative and financial powers.
R19MC202.4	Understand the constitutional amendments and emergency provisions.
R19MC202.5	Understand the fundamental right to equality, freedom, life and personal freedom.

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SEMESTER V

R19ME301	Engineering Metrology and Measurements	L	T	P	C
		3	0	0	3

1.Course Description:

Metrology and Measurements is a foundational course designed towards providing students an in-depth understanding of measuring principles, methodologies, and their applications in an assortment of science, technology, and engineering professions. The course of study addresses fundamental concepts in metrology, the science of measurement, and investigates various types of the measurements, instruments, and systems of measurement employed in industrial, scientific, and research environments.

2. Course Objectives:

1. To get acquainted with students with the principles and applications of metrology in engineering and science.
2. To give pupils actual knowledge of various measurement techniques and instruments.
3. To gain experience in measurement uncertainty analysis and quality assurance.
4. To encourage students to use metrology in research, development, and industry settings.

3.Syllabus

Unit-I: Basics of Industrial Metrology

Metrology: Definition and concept of Metrology, Need of Inspection; Elements: Work piece, Measuring Instruments, Persons, Environment, and their effect on Precision and Accuracy; Standards: Types of standards; Calibration: Precision and Accuracy, Errors, Errors in Measurements; Selection of Instruments and measurement systems; Quality management;

Unit-II: Linear, Angular Instruments and its Applications

Linear Measuring Instruments: Evolution, Instrument Classification, Limit gauges; Gauge design terminology: Procedure, Concepts of Interchangeability, Selective assembly; Angular measuring instruments: Bevel protractor, Clinometers, Angle gauges, Spirit levels, Sine bar, Angle alignment telescope , Autocollimator;

Unit-III: Advances in Metrology Instruments and its Applications

Laser: Basic concept of lasers, Advantages of lasers, Laser Interferometers, Types of Lasers Interferometer, Straightness; Coordinate Measuring Machine (CMM): Basic concept, Types of CMM, Constructional features, Probes, Accessories, Software; Machine vision system: Basic concepts of Machine Vision System, Applications;

Unit-IV: Form Measuring Instruments and Its Applications

Form Measuring Instruments: Principles, Methods of straightness , Flatness measurement, Thread measurement, Gear measurement, Surface finish measurement, Roundness measurement;

Unit-V: Measurement of Power, Flow and Temperature

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Measurement of Power: Force, Torque, Power, Mechanical, Pneumatic, Hydraulic and Electrical; Measurement of Flow: Venturimeter, Orifice meter, Rotameter, Pitot tube; Measurement of Temperature: Bimetallic strip, Thermocouples, Electrical resistance thermometer, Reliability, Calibration;
Text Books:
1. Gupta. I.C., Engineering Metrology, Dhanpatrai Publications, 2015 Edition. 2. Holman J P, Experimental methods for Engineers, Tata McGraw Hill, 8th Edition, 2012. 3. Beckwith, Marangoni, Lienhard, Mechanical Measurements, Pearson Education, 2014. 4. Jain R.K., Engineering Metrology, Khanna Publishers, 2017 Edition.
Reference Books:
1. Alan S. Morris, The essence of Measurement, Prentice Hall of India, 2012. 2. Charles Reginald Shotbolt, Metrology for Engineers, 5th edition, Cengage Learning EMEA, 2012. 3. Donald Peckman, Industrial Instrumentation, Wiley Eastern, 2014. 4. Raghavendra, Krishnamurthy Engineering Metrology & Measurements, Oxford Univ. Press, 2013.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME301.1	(Apply) Calibrate the basic instruments to detect errors and incorporate them into measurements.
R19ME301.2	(Apply) Demonstrate the key concepts of linear and angular measurement equipment for applications in industry.
R19ME301.3	(Analyse) Evaluate the numerous features of a machined component using the CMM and conduct computer-aided inspection.
R19ME301.4	(Apply) Demonstrate the techniques of form measurement used for industrial components.
R19ME301.5	(Apply) Apply quality control and inspection strategies to guarantee measurement accuracy and dependability in industrial operations.

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R19ME302	Dynamics of Machines	L	T	P	C
		3	0	0	3

1. Course Description:

This course covers the principles of dynamic force analysis, balancing of machines, and vibrations in mechanical systems. Topics include inertia forces, balancing techniques for rotating masses, free and forced vibration analysis, and speed control mechanisms like governors and gyroscopes. Provide learners to analyze and control vibrations to ensure smooth operation and efficiency in mechanical systems.

2. Course Objectives:

1. Understand dynamic force analysis principles, including D'Alembert's principle, to analyze reciprocating engines and flywheel applications effectively.
2. Learn techniques for balancing machines, both statically and dynamically, to ensure optimal performance and reduce vibrations in mechanical systems.
3. Develop proficiency in analyzing free and forced vibrations in mechanical systems, including torsional vibration analysis and speed control mechanisms such as governors and gyroscopes.

3. Syllabus

Unit-I: Dynamic Force Analysis

Dynamic force analysis: Inertia force and Inertia torque; D Alembert's principle: Dynamic Analysis in reciprocating engines, Gas forces, Inertia effect of connecting rod, Bearing loads, Crank shaft torque; Turning moment diagrams; Fly Wheels: Flywheels of punching presses, Applications of Flywheel.

Unit-II: Balancing of Machines

Balancing of rotating masses: Static and dynamic balancing; Single rotating mass: Same plane, Different Plane; Several rotating masses: Same plane, Different plane.

Balancing of reciprocating masses: Single cylinder engine, Multi-cylinder inline, V-engines, Partial balancing in engines; Applications for static and Dynamic Balancing.

Unit-III: Free Vibration

Basic features of vibratory systems; Degrees of freedom: single degree of freedom; Free vibration: Equations of motion, Natural frequency; Types of Damping, Damped vibration; Torsional vibration of shaft; Critical speeds of shafts; Torsional vibration: Two and three rotor torsional systems; Applications of Free Vibration analysis.

Unit-IV: Forced Vibration

Response of one degree freedom systems to periodic forcing; Harmonic disturbances: Disturbance caused by unbalance; Support motion: transmissibility, Vibration isolation vibration measurement; Applications of Forced Vibration analysis.

Unit-V: Speed Control Mechanism

Governors: Overview; Types: Centrifugal governors, Gravity controlled and spring controlled centrifugal governors; Characteristics: Effect of friction, Controlling force curves, Applications of governors; Gyroscopes: Gyroscopic forces and torques, Gyroscopic stabilization, Gyroscopic effects in Automobiles, ships and airplanes, Applications of Gyroscopes.

Text Books:

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1. Rattan, S.S, Theory of Machines, 3rd Edition, Tata McGraw-Hill, 2017.
2. Khurmi, R. S., Theory of Machines, 14th Edition, S Chand Publications, 2014.

References:

Reference Books :

1. Sadhu Singh, Theory of Machines, 2nd Edition, Pearson Education, 2015.
2. Robert, L. Norton, Kinematics and dynamics of machines, First Edition, CBS Publishers and Distributors, 2013.
3. Rao. J. S. and Dukkipati. R.V., Mechanisms and Machine Theory, 2nd Edition, Wiley-Eastern Ltd., New Delhi, 2015.

MOOC/SWAYAM/NPTEL Course:

1. https://archive.nptel.ac.in/courses/112/101/112101096/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME302.1	Understand the principles of dynamic force analysis and apply them to analyze reciprocating engines and flywheel applications effectively.
R19ME302.2	Analyze techniques for balancing machines to ensure optimal performance and reduce vibrations in mechanical systems.
R19ME302.3	Apply principles of vibration analysis to design mechanical systems with reduced vibration and improved efficiency.
R19ME302.4	Develop proficiency in analyzing free vibrations and forced vibrations in mechanical systems.
R19ME302.5	Apply the knowledge of speed control mechanisms such as governors and gyroscopes and their applications in various machines.

R19ME303	**Heat and Mass Transfer**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

1.Course Description:

The basic concepts, hypotheses, and practical implications of heat and mass transfer in many engineering systems as well as procedures are investigated in the intermediate-level course Heat and Mass Transfer. Conduction, convection, radiation, and diffusion are among the mechanisms of heat and mass transmission that are covered in this course. Their mathematical formulations and solutions are also examined. In engineering practice, heat exchangers, cooling systems, and mass transfer equipment are frequently employed. Students will learn how to evaluate and construct these components.

2. Course Objectives:

1. To impart to students a basic knowledge of the principles and mechanisms of heat transfer.
2. To familiarize students with the mathematical modeling and evaluation of mass and heat transport systems using mathematics.

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3. To acquire competence in mass transfer and heat exchanger design and analysis.
4. To provide students the tools they need to apply the ideas of heat and mass transport to engineering design, optimized performance, and problem resolution.

3.Syllabus

Unit-I: Conduction

Conduction: General Differential equation of Heat Conduction, Cartesian & Polar Coordinates, One Dimensional Steady State Heat Conduction, plane& Composite Systems, Conduction with Internal Heat Generation, Extended Surfaces, Unsteady Heat Conduction, Lumped Analysis, Semi Infinite and Infinite Solids;

Unit-II: Convection

Convection: Free & Forced Convection, Hydrodynamic, Thermal Boundary Layer, Dimensionless parameters, Free &Forced Convection during external flow over flat plates, cylinders, Internal flow through tubes;

Unit-III: Phase Change Heat Transfer And Heat Exchangers

Boiling and Condensation: Nusselt's theory, Regimes of Pool boiling, Flow boiling. Correlations in boiling & condensation; Heat Exchanger:, Overall Heat Transfer Coefficient, Fouling Factors, LMTD method, NTU method;

Unit-IV: Radiation

Radiation: Basic laws of radiation; Black Body Radiation, Grey body radiation, Shape Factor, Electrical Analogy, Radiation Shields;

Unit-V: Mass Transfer

Mass Transfer: Basic Concepts, Diffusion Mass Transfer, Fick's Law of Diffusion, Steady state Molecular Diffusion, Convective Mass Transfer, Momentum, Heat & Mass Transfer Analogy, Convective Mass Transfer Correlations;

Text Books:

1. Yunus A Cengel & Afshin J. Ghajar, Heat Transfer and Mass Transfer – Fundamentals & Applications, 5/e, McGraw-Hill., 2017
2. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2016.

Reference Books:

1. Holman, J.P., Heat and Mass Transfer, Tata McGraw Hill, 2015
2. R.C. Sachdeva, Fundamentals of Engineering Heat & Mass transfer, New Age International Publishers, 2014
3. Nag, P.K., Heat Transfer, Tata McGraw Hill, New Delhi, 2012
4. Frank P. Incropera and David P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, 2017.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME303.1	(Analyze) Analyze the effectiveness of fins and solve steady and unsteady heat conduction issues with various boundary conditions.
R19ME303.2	(Analyze) Compute the fluid's thrust and the rate of convective heat transfer using essentially empirical correlation related to various flow types and geometries.
R19ME303.3	(Apply) Handle the sizing and rating issues related to various heat exchanger types.
R19ME303.4	(Apply) Calculate the heat transfer from radiation between enclosures.
R19ME303.5	(Apply) Recognize the basic principles underpinning the concept of mass transfer.

R19ME304	**Machine Design**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

1. Course Description:

This course provides a comprehensive understanding of the principles and methodologies involved in designing various machine components and systems. Students will learn about the fundamental concepts of engineering design, including stress analysis, material selection and mechanical systems' behaviour. This course covers topics such as static and dynamic loading, fatigue analysis and manufacturing considerations. Emphasis is placed on applying engineering principles to solve real-world design problems efficiently and effectively. By the end of the course, students will be equipped with the knowledge necessary to design robust and reliable machine components that meet performance requirements and industry standards.

Course Objectives:

1. To understand the principles and methodologies of machine component and system design, encompassing stress analysis, material selection, and mechanical behavior.
2. To analyze static and dynamic loading conditions to determine their impact on machine components and systems.
2. 3. To apply engineering principles to solve real-world design challenges efficiently, resulting in the creation of robust and reliable machine components that meet performance requirements and industry standards.

Syllabus

Unit-I: Steady Stresses and Variable Stresses in Machine Members

Design Process: factors influencing machine design, selection of materials based on mechanical properties; Preferred numbers; Direct, Bending and torsional loading; Modes of failure; Factor of safety; Combined loads: Principal stresses calculation; Eccentric loading;

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Curved beams: crane hook, 'C' frame; Theories of failure; Design based on strength and stiffness; stress concentration; Fluctuating stresses; Endurance limit; Design for finite and infinite life under variable loading; Exposure to standards.

Unit-II: Design of Shafts and Couplings

Design of solid and hollow shafts: based on strength, rigidity and critical speed; Keys &splines; Rigid & flexible couplings.

Unit-III: Design of Temporary and Permanent Joints

Threaded fasteners; Bolted joints including eccentric loading; Knuckle joints; Cotter joints; Welded joints: Butt, Fillet, parallel transverse fillet welds; welded joints subjected to bending, torsional and eccentric loads; riveted joints for structures; theory of bonded joints.

Unit-IV: Design of Springs and Bearings

Springs: types, design of helical & concentric springs, surge in springs, Design of laminated springs, rubber springs; Sliding contact and rolling contact bearings; Design of Hydrodynamic journal bearings; Somerfield Number, Raimondi & Boyd graphs; Selection of Rolling Contact bearings.

Unit-V: Design of Flexible and Rigid drives

Design of Flat belts and pulleys; Selection of V belts and pulleys; Design of Transmission chains and Sprockets.

Spur Gears: Load concentration factor, dynamic load factor, surface compressive strength, bending strength, design & analysis of spur gear, check for dynamic and wear considerations; Design of multi speed gear box for machine tool applications

Text Books:

1. Joseph Edward Shigley, Charles R. Mischke, Mechanical Engineering Design, McGraw Hill, 11th edition, 2020.
2. Bhandari. V.B, Design of Machine Elements, Tata McGraw-Hill Education, 5th edition, 2020

References:

Reference Books:

1. Robert L. Norton, Machine Design – An Integrated Approach, Prentice Hall International Edition, 5th edition, 2018.
2. Sundararajamoorthy T. V, Shanmugam .N, Machine Design, Anuradha Publications, 2015
3. Sharma. C.S, Purohit. K., Design of Machine Elements, Prentice-Hall of India, 2003.
4. Ansel C Ugural, Mechanical Design – An Integral Approach, 1st Edition, Tata McGraw-Hill Book Co, 2004.
5. Merhyle Franklin Spotts, Terry E. Shoup, and Lee Emrey Hornberger, Design of Machine Elements, 8th Edition, Printice Hall, 2004.
6. PSG Design Data Hand Book, PSG College of Tech Coimbatore.

MOOC/SWAYAM/NPTEL Courses:

1. https://archive.nptel.ac.in/courses/112/106/112106137/

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2.	https://www.nptelvideos.com/course.php?id=791	
3.	https://archive.nptel.ac.in/courses/112/105/112105125/	

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME304.1	Calculate the steady stresses and variable stresses in various machine components for structural integrity assessment.
R19ME304.2	Design the shafts, keys and couplings suited to specific application.
R19ME304.3	Design the Temporary and Permanent joints for structural and mechanical assemblies.
R19ME304.4	Design the helical springs, leaf springs, Ball bearings and hydrodynamic bearings for efficient and reliable mechanical systems.
R19ME304.5	Design the Spur Gear and Gear Boxes for the given application.

R19ME311	**Metrology and Dynamics Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

1. Course Description

Metrology and Dynamics Laboratory is a hands-on course that provides students firsthand knowledge with gauging techniques, instrumentation, and dynamic statistical analysis. The course of study incorporates theoretical concepts with real-world applications to help students strengthen their abilities in conducting experiments, gathering information, evaluation, and presentation.

2. Course Objectives:

1. To provide learners with a wide range of instruments for measuring and how to utilize them.
2. To offer students real-world experience in the calibration as well as validation of instrumentation.
3. To demonstrate to students the significance of accuracy of measurement, precision, and error analysis.
4. To providing students hands-on instruction with conducting experiments to acquire knowledge about the constantly changing behavior of mechanical systems.
5. To familiarize students with single and multi-degree-of-freedom systems as well as vibration analysis methods and concepts.

3.List of Experiments

Metrology

1. Calibration of linear measuring equipments
2. Compute the angular measurement of the given work piece
3. Establish relationships about the variables affecting surface roughness and how surface texture changes can affect the functioning and performance of machined components.

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4. Deliberate about the critical characteristics and variables that determine the effectiveness and fineness of gear tooth profiles. 5. Compute the form measurements of the work piece 6. Calibrate the thermal measuring equipment **Dynamics** 7. Determine the sensitivity and performance characteristics of various governor 8. Determine the gyroscopic effect. 9. Determination critical speed of shaft with concentrated loads (Whirling of shafts) 10. Determination of natural frequency for Single degree of freedom - Spring Mass System 11. Determination of natural frequency of Transverse vibration of Free-Free beam – with and without concentrated masses. 12. Determination of natural frequency of Cantilever Beam – Forced Vibration Setup 13. Experimental determination of balancing of rotating & reciprocating masses.
Text Books:
1. Bechwith-Marangoni-Lienhard, Mechanical Measurements, Pearson Education India, Sixth edition, 2013. 2. Rattan, S. S. Theory of Machines. Tata McGraw-Hill Education, 2017.
References Books:
1. Jay L. Bucher, The Metrology Handbook, 2nd Edition, ASQ Measurement Quality Division, Second Edition, 2012. 2. Uicker, John Joseph, Gordon R. Pennock, and Joseph Edward Shigley, Theory of Machines and Mechanisms, Vol. 1, New York, NY: Oxford University Press, Fifth Edition, 2016.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME311.1	(Apply) Execute calibration protocols on elementary instruments to detect discrepancies and integrate error corrections into measurements.
R19ME311.2	(Evaluate) To evaluate the delicate details of a machined component, acquire the proper linear and angular measuring tools
R19ME311.3	(Evaluate) Evaluate the geometric shape characteristics of machined features
R19ME311.4	(Apply) Exploring Kinematics: Analysis of Mechanical Systems
R19ME311.5	(Apply) Exploring Rotational Dynamics: Analysing Moment of Inertia and Centre of Mass in Complex Objects

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R19ME312	Thermal Engineering Laboratory	L	T	P	C
		0	0	2	1

1. Course Description:

The Thermal Engineering Laboratory is designed to provide students with hands-on experience in various aspects of thermal engineering principles and applications. Through a combination of theoretical knowledge and practical experimentation, students gain a deeper understanding of thermodynamics, heat transfer, and thermal systems.

2. Course Objectives:

1. systematically giving students actual, hands-on experience, reinforce theoretical principles covered in thermodynamics and heat transfer classes.
2. Develop students to the use and operation of popular laboratory instruments used in thermal engineering, such as heat exchangers, calorimeters, and instruments for measuring thermal conductivity.
3. Examine sustainable energy technology, such as energy efficiency, renewable energy sources, and environmental concerns, as well as energy conversion systems.
4. Communicate effectively and work collaboratively in multidisciplinary teams on Develop students' capacity to recognise, evaluate, and resolve thermal system-related engineering challenges while promoting critical thinking and creative problem-solving.

3. Syllabus

List of Experiments:

1. Valve Timing and Port Timing diagrams.
2. Performance Test on 4 – stroke Diesel Engine.
3. Heat Balance Test on 4 – stroke Diesel Engine.
4. Determination of Flash Point and Fire Point of various fuels / lubricants.
5. Study on Steam Generators and Turbines.
6. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
7. Determination of heat transfer coefficient under natural/forced convection.
8. Determination of Thermal conductivity of composite wall.
9. Heat transfer from pin-fin apparatus (natural & forced convection modes)
10. Determination of emissivity of a grey surface.
11. Effectiveness of Parallel / counter flow heat exchanger.
12. Determination of COP of a refrigeration system

Text Books:

1. Kothandaraman. C. P., Domkundwar. S, Domkundwar. A.V., A course in Thermal Engineering & Quot;, Fifth Edition, Dhanpat Rai & amp; sons , 2012.
2. Er. Rajput. R. K., Thermal Engineering, tenth Edition, Lakshmi publication, 2015.
3. Cengel Y. A. & Boles M. A. Thermodynamics - an Engineering Approach, 9/e, Tata McGraw Hill, 2019

Reference Books:

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1. Ramalingam. K. K., Thermal Engineering, First Edition, Scitech publication (Ind) (p) LTD,2015.
2. Ganesan. V, Internal Combustion Engines, Fourth Edition, Tata Mcgraw-Hill 2016
3. Sarkar. B.K. Thermal Engineering, First Edition, Tata McGraw-Hill Publishers, 2011
4. Rudramoorthy, R, Thermal Engineering, First Edition, Tata McGraw-Hill, New Delhi,2010
5. Sonntag R. E., Borgnakke C. & Van Wylen, G., Fundamentals of Thermodynamics, 10/e John Wiley and Sons , 2019

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME312.1	**(Apply)** Conduct tests on heat conduction apparatus and evaluate thermal conductivity of materials.
R19ME312.2	**(Apply)** Conduct tests on natural and forced convective heat transfer apparatus and evaluate heat transfer coefficient.
R19ME312.3	**(Analyze)** Evaluate the radiative heat transfer apparatus and evaluate emissivity of grey surface.
R19ME312.4	**(Analyze)** Evaluate the effectiveness of parallel/counter flow heat exchanger apparatus.
R19ME312.5	**(Analyze)** Evaluate the COP of refrigeration.

R19ME313	**CAD/CAM Laboratory**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

1. Course Description:

This laboratory deals with the detailed engineering of 3D models and/or 2D drawings of components using CAD software. Computer-aided design (CAD) is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. Computer-aided manufacturing (CAM) is the use of computer software to control machine tools and related machinery in the manufacturing of workpieces.

2. Course Objectives:

1. To gain practical experience in handling 2D drafting and 3D modelling software systems.
2. To study the features of CNC Machine Tool.
3. To expose students to modern control systems (Fanuc, Siemens etc.)
4. To know the application of various CNC machines like CNC lathe, CNC Vertical Machining centre, CNC EDM and CNC wire-cut and studying of Rapid prototyping.

3.List of Experiments

I. 3D GEOMETRIC MODELLING

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List of Experiments

1. Introduction of 3D Modelling software

Creation of 3D assembly model of following machine elements using 3D Modelling software

2. Oldham's Coupling
3. Plummer Block
4. Screw Jack
5. Lathe Tailstock
6. Universal Joint
7. Machine Vice
8. Stuffing box
9. Crosshead
10. Safety Valves
11. Non-return valves
12. Connecting rod
13. Piston
14. Crankshaft

2. MANUAL PART PROGRAMMING

(i) Part Programming - CNC Machining Centre a) Linear Cutting. b) Circular cutting. c) Cutter Radius Compensation. d) Pocket milling.

(ii) Part Programming - CNC Turning Centre a) Straight, Taper and Radius Turning. b) Thread Cutting. c) Rough and Finish Turning Cycle. d) Drilling and Tapping Cycle

3. COMPUTER AIDED PART PROGRAMMING

e) CL Data and Post process generation using CAM packages. f) Application of CAPP in Machining and Turning Centre.

Text Books:

1. Gopalakrishna K.R., Machine Drawing, 22nd Edition, Subhas Stores Books Corner, Bangalore, 2015.

References:

Reference Books:

1. Junnarkar, N.D., Machine Drawing, 1st Edition, Pearson Education, 2006.
2. P.S.G. Design Data Book, 2019.
3. Luzadder, Warren.J., and Duff, Jon. M., Fundamentals of Engineering Drawing, Prentice Hall India Pvt. Ltd., Eastern Economy Edition, Eleventh Edition, 2020.
4. Chang, T. C., Wysk, R.A., Wang, H. P, Computer aided Manufacturing, Prentice Hall, Third Ed, 2008.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME313.1	Understand and interpret machine manufacturing drawings
R19ME313.2	Develop 2D and 3D models using high end modelling software's
R19ME313.3	Apply engineering drawing standards as per BIS conventions
R19ME313.4	Understand the CNC control in modern manufacturing system
R19ME313.5	Prepare CNC part programming and perform manufacturing

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R19MC201	Environmental Science	L	T	P	C
		1	0	0	NC

1. Course Description:

Environmental science should provide for the engineers to develop sustainable practices and technologies. Also, it ensures engineers can design and implement projects that comply with these regulations, avoiding legal issues and laws and potential fines. By incorporating environmental science, engineers can better assess and mitigate negative health effects related to pollution and environmental degradation. To raise awareness about sustainability all over the world to protect the current resources for future generations.

2. Course Objectives:

1. Analyze how living organisms interact with their environment.
2. To Identify how the environment affects the human world and its importance.
3. Educate on topics such as biodiversity, natural resources, pollution control and waste management.
4. Understand how the environment is protected by the Constitution.

3. Syllabus:

Unit-I: Environment and Ecosystem

Key environmental issues: their basic causes and sustainable solutions; concept of an ecosystem; structure and function of an ecosystem; producers, consumers and decomposers; energy flow in the ecosystem, food chains and food webs.

Unit-II: Environmental Pollution

Primary and secondary air pollutants; Air, Water, Marine and soil pollution: causes, effects and control measures.

Unit-III: Risk and Security of Environment

Heavy metals, E-waste and Hazardous waste management; green and blue revolution; GM crops: merits and demerits; ecological impacts of modern agriculture; Bio fertilizer technology: organic farming.

Unit-IV: Energy Resources

Non-renewable energy resources: oil, Natural gas, Coal; Renewable energy resources: Solar energy, Hydroelectric power, Wind, biomass and geothermal energy.

Unit-V: Social Issues and the Environment

Environmental ethics: Issues and possible solutions; water conservation: rain water harvesting, watershed management; Sustainable development; global climatic change: global warming, ozone layer depletion.

Text Book:

1. Babu E. and Tharaneeswaran V., "Environmental Science", V K Publishers, 2019.

References:

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Reference Books
1. Miller T. G. and Spoolman S. E., "Environmental Science", Cengagelearning16th Edition, 2017. 2. Sinha J., "Environmental Science", Galgotia Publications, 2nd Edition, 2011. **Journals:** 1. Environmental Chemistry Letters (https://link.springer.com/article/10.1007/S10311-020-01100-Y) 2. Taylor& Francis (https://www.tandfonline.com/doi/pdf/10.1080/00908327709545594) 3. Environmental Research (https://www.sciencedirect.com/science/article/pii/S0013935123016766) 4. Energy Strategy Reviews (https://www.sciencedirect.com/science/article/pii/S2211467X2200133X) 5. Environmental Development (https://www.sciencedirect.com/science/article/pii/S2211464515300099) **Video References:** 1. https://www.youtube.com/watch?v=ytxjYhcGNBs 2. https://www.youtube.com/watch?v=oSbUp3XYQX8 **MOOC/SWAYAM/Online Courses:** 1. https://nptel.ac.in/courses/105104099/ 2. https://www.youtube.com/watch?v=CXCT2R1K6Ts 3. https://www.youtube.com/watch?v=89B9IT0Tl-Q 4. https://www.youtube.com/watch?v=p-lSPDDdVtc 5. https://www.youtube.com/watch?v=Y5B1nWYle40

4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19MC201.1	To understand about eco system and its current impacts by implementing sustainability
R19MC201.2	Acquire the concept of pollution and its types and prevention to overcome the issues.
R19MC201.3	To enhance the vision of waste management system and preservation and making bio fertilizers
R19MC201.4	To obtain the knowledge of energy sources, fossil fuels and current implementation to balance the futuristic needs
R19MC201.5	To know about the Environmental ethics: Issues and water conservation, rain water harvesting, watershed management -Sustainable development

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SEMESTER VI

R19AM303	Artificial Intelligence and Machine Learning	L	T	P	C
		3	0	0	3

1. Course Description:

This course offers a comprehensive exploration of the foundational principles and core concepts in Artificial Intelligence (AI). Beginning with an introduction to the history and applications of AI, the course progressively delves into intelligent agents, problem-solving, search algorithms, and extends to encompass knowledge representation and planning. Machine learning is a branch of artificial intelligence that enables systems to learn from data and improve their performance over time without being explicitly programmed. Students will gain a solid understanding of various machine learning algorithms, their theoretical underpinnings, and how to apply them both artificial intelligence and machine learning to real-world problems.

2. Course Objectives:

1. To study the structure of agents and the nature of environments
2. To learn the search algorithms of AI in different environments
3. To Learn and apply adversarial search techniques to solve problems in dynamic environments.
4. To understand the basic concepts of machine learning.
5. To understand and build supervised and unsupervised learning models.

3. Syllabus:

Unit-I: INTELLIGENT AGENTS

Introduction to artificial intelligence; Intelligent agents: agents & environment, concept of rationality, nature of environments, structure of agents.

Case Study: Autonomous Delivery Robots which interact with their surroundings and navigate through dynamic environments to deliver packages.

Unit-II: PROBLEM SOLVING AGENTS

Uninformed search strategies, Heuristic search strategies, heuristic functions; Local search and optimization problems, local search in continuous space, search with nondeterministic actions, search in partially observable environments, online search agents and unknown environments.

Case Study: Autonomous vehicle Navigation in Unknown Environments

Unit-III: GAME PLAYING AND CSP

Adversarial search: Games, optimal decisions in games, alpha - beta pruning, stochastic games, partially observable games; Constraint satisfaction problems; constraint propagation, backtracking search for CSP, local search for CSP, structure of CSP Case Study: Artificial intelligence system plays chess to make optimal moves in a partially observable and dynamic environment.

Unit-IV: SUPERVISED LEARNING

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Machine Learning; Types of Machine Learning: Supervised Learning, Unsupervised Learning; Basic Concepts in Machine Learning ; Machine Learning Process; Weight Space; Testing Machine Learning Algorithms; A Brief Review of Probability Theory : Turning Data into Probabilities , The Bias-Variance Trade off. Linear Models for Regression; Linear Basis Function Models; The Bias-Variance Decomposition; Bayesian Linear Regression; Common Regression Algorithms: Simple Linear Regression, Multiple Linear Regression: Linear Models for Classification: Common Classification Algorithms: k-Nearest Neighbours, Decision Trees, Random Forest model, Support Vector Machines.

Unit-V: UNSUPERVISED LEARNING

Mixture Models and EM; K-Means Clustering; Dirichlet Process Mixture Models; Spectral Clustering; Hierarchical Clustering; The Curse of Dimensionality; Dimensionality Reduction: Principal Component Analysis; Latent Variable Models(LVM): Latent Dirichlet Allocation (LDA). Reinforcement Learning, Representation Learning – Neural Networks – Active Learning – Ensemble Learning – Bootstrap Aggregation – Boosting – Gradient Boosting Machines.

Text Books:

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.
2. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020.
3. Tom Mitchell, "Machine Learning", McGraw-Hill, 2017.

References:

Reference Books:

1. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, New Delhi, 2017
2. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.

Video References:

1. https://www.youtube.com/watch?v=JxgmHe2NyeY
2. https://www.youtube.com/watch?v=z18nw4adsx4

Web Resourcess:

1. https://alex.smola.org/drafts/thebook.pdf
2. https://www.cin.ufpe.br/~cavmj/Machine%20-%20Learning%20%20Tom%20Mitchell.pdf

MOOC/SWAYAM/NPTEL Courses:

1. Introduction to Machine learning- MIT OpenCourseWare
2. Essential Mathematics for Artificial Intelligence on edX

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AM303.1	Implement a study of agents' structures and diverse environments in AI.
R19AM303.2	Apply various AI search algorithms for different environmental scenarios using the knowledge and skills acquired.

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R19AM303.3	Implement a comprehensive study of adversarial search techniques and resolving constraint satisfaction problems in AI.
R19AM303.4	Apply logical and probabilistic inference mechanisms to improve decision-making in AI systems.
R19AM303.5	Analyze knowledge representation techniques and planning algorithms vital for Artificial Intelligence

R19ME305	Finite Element Analysis	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive understanding of the theoretical foundations and practical applications of Finite Element Analysis in engineering. Students will learn how to discretize complex structures into finite elements and apply appropriate boundary conditions to simulate real-world conditions accurately. This course aims to develop students' skills in interpreting FEA results and assessing the behavior, performance, safety of engineering designs. Emphasis will be placed on applying FEA techniques to solve practical engineering problems, optimize designs and make informed design decisions. By the end of the course, students will be equipped with the knowledge and skills necessary to effectively utilize FEA as a powerful tool in engineering analysis and design processes.

1. Course Objectives:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To understand the theoretical foundations and principles of finite element analysis (FEA) for engineering applications.
3. To learn how to discretize complex structures into finite elements and apply appropriate boundary conditions.
4. To apply FEA techniques to solve real-world engineering problems, optimize designs and make informed design decisions.

2. Syllabus

Unit-I: Introduction

Historical Background of FEA; Mathematical Modeling of field problems in Engineering; Governing Equations; Discrete and continuous models; Boundary, Initial and Eigen Value problems; Weighted Residual Methods; Variational Formulation of Boundary Value Problems; Ritz Technique; Basic concepts of the Finite Element Method.

Unit-II: One Dimensional Problems

One Dimensional Second Order Equations: Discretization, Element types, Linear & Higher Order Elements, Derivation of Shape functions, Stiffness matrices & force vectors, Assembly of Matrices, Solution of problems from solid mechanics and heat transfer; Longitudinal vibration frequencies and mode shapes; Fourth Order Beam Equation: Transverse deflections, Natural frequencies of beams.

Unit-III: Two Dimensional Scalar Variable Problems

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Second Order 2D Equations involving Scalar Variable Functions: Variational formulation, Finite Element formulation, Triangular elements, Shape functions, element matrices and vectors, Application to Field Problems, Thermal problems; Torsion of Non circular shafts; Quadrilateral elements; Higher Order Elements.

Unit-IV: Two Dimensional Vector Variable Problems

Equations of elasticity: plane stress, plane strain; axisymmetric problems; Body forces and temperature effects; Stress calculations: Plate and shell elements.

Unit-V: Isoparametric Formulation

Natural co-ordinate systems; Isoparametric elements: Shape functions; One and two dimensions; Serendipity elements; Numerical integration and application to plane stress problems; Matrix solution techniques: Dynamic problems; Introduction to Analysis Software.

Text Books:

1. Reddy. J.N., An Introduction to the Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2017
2. Seshu, P, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

References:

1. Bhatti Asghar M, Fundamental Finite Element Analysis and Applications, John Wiley & Sons, 2005 (Indian Reprint 2013).
2. Chandrupatla & Belagundu, Introduction to Finite Elements in Engineering, 3rd Edition, Prentice Hall College Div, 2001.
3. Logan, D.L., A first course in Finite Element Method, Thomson Asia Pvt. Ltd., 2011.
4. Rao, S.S., The Finite Element Method in Engineering, 3rd Edition, Butterworth Heinemann, 2010.
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley Student Edition, 2007.

MOOC/SWAYAM/NPTEL Courses:

1. https://archive.nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112104193
3. https://archive.nptel.ac.in/courses/112/105/112105308/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME305.1	Understand the concepts of Mathematical Modeling in Engineering to solve the various field problems
R19ME305.2	Apply finite element formulations to solve one dimensional problems.
R19ME305.3	Apply finite element formulations to solve two dimensional scalar problems.
R19ME305.4	Apply finite element method to solve two dimensional vector problems.

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R19ME305.5	Apply finite element method to solve problems on isoparametric element and dynamic problems.

R19ME351	Fluid Power Systems and Industrial Automation	L	T	P	C
		2	0	2	3

1. Course Description:

This course provides students with a comprehensive understanding of fluid power systems and industrial automation, blending theoretical knowledge with practical applications. Through a structured curriculum encompassing lectures, demonstrations, and hands-on exercises, students will develop proficiency in designing, analyzing, and implementing hydraulic and pneumatic circuits, as well as mastering Programmable Logic Controllers (PLCs) and supervisory control systems.

2.Course Objectives:

1. To recognize the standard symbols and to understand the functions of basic fluid power generation and actuation elements.
2. To realize the functions of fluid regulation and control elements and its typical uses in fluid power circuit and to acquire the practice on assembling the various types of pneumatic circuits.
3. To familiar and exercise the design procedure of various types of pneumatic and hydraulic fluid power circuits and to provide a training to create the various types of hydraulic circuits.
4. To learn about the fundamentals of Programmable Logic Controller.
5. To familiarize the Data Communication and Supervisory Control Systems.

3.Syllabus

Unit-I: Fluid Power System Generation and Actuators

Need For Automation; Classification of Drives: Hydraulic, Pneumatic and Electric; Comparison: ISO Symbols for their Elements; Selection Criteria; Generating Elements: Hydraulic Pumps and Motor Gears, Vane, Piston Pumps; Motors: Selection and Specification, Drive Characteristics, Utilizing Elements; Linear Actuator: Types, Mounting Details, Cushioning, Power Packs, Accumulators.

Unit-II: Control And Regulating Elements

Control and Regulating Elements: Direction, Flow and Pressure Control Valves; Methods of Actuation: Types, Sizing of Ports, Spool Valves; Operating Characteristics; Electro Hydraulic Servo Valves: Types, Characteristics and Performance.

Unit-III: Circuit Design for Hydraulic and Pneumatics

Typical Design Methods: Sequencing Circuits Design, Combinational Logic Circuit Design, Cascade Method, KV Mapping; Electrical Control of Pneumatic and Hydraulic Circuits; Use of Relays; Timers; Counters and PLC in pneumatics and hydraulics.

Unit-IV: Programmable Logic Controller

Programmable Logic Controller (PLC): Functions, Features, Selection; Architecture; Mitsubishi PLC: Programming standard and types, Basics of PLC Programming, Ladder Logic Diagrams, Communication in PLC, Programming Timers and Counters, Data Handling, PLC modules; Advanced motion controlled Multi Axis PLC

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Unit-V: Data Communication and Supervisory Control Systems
Data Communications: Modbus, HART, DeviceNet, Profibus, Fieldbus, RS232, RS485, Modbus, mechatrolink, CAN, EtherCAT; Introduction to Supervisory Control Systems: SCADA, Distributed Control System (DCS), Safety Systems, human machine interfaces; Total Integrated Automation (TIA); Industry 4.0.
List of Laboratory Experiments / Exercises:
1. Design and construct a hydraulic circuit to control the movement of a single-acting hydraulic cylinder using manual and automatic control valves. 2. Develop a pneumatic system for automation using pneumatic actuators and control valves. 3. Design and simulate a pneumatic circuit for sequential control of multiple actuators in a robotic assembly line. 4. Design and simulate the Pneumatic circuits with pressure control, flow control , direction control and Logical control 5. Design and simulate a pneumatic circuit to automate the batch processing plant. 6. Design and simulate a PLC ladder logic program for Basic Logic Gates. 7. Design and Simulate PLC programs utilizing timers and counters for various industrial applications. 8. Design and simulate a PLC ladder logic program to control the sequence of operations in a conveyor belt system, including start/stop, speed control, and emergency stop. 9. Develop a PLC-based control system for a water treatment plant, including monitoring water levels, controlling pumps, and regulating chemical dosing. 10. Develop a PLC program to automate the operation of a batch processing plant, including mixing, heating, and packaging processes.
Text Books:
1. Antony Esposito, Fluid Power with Application, Prentice-Hall, Seventh Edition, 2014. 2. Peter Rohner, Fluid Power Logic Circuit Design, the Macmillan Press Ltd., London, 1979. 3. Frank D, Petruzella, Programmable Logic Controller, McGraw – Hill Publications, Fifth Edition, 2016.
References:
Reference Books: 1. Lucas, M.P., Distributed Control System, Van Nastrand Reinhold Company, New York, Second Edition, 1986. 2. Mackay S., Wrijut E., Reynders D. and Park J., Practical Industrial Data Networks Design, Installation and Troubleshooting, Newnes Publication, Elsevier, First Edition, 2012. 3. Patranabis. D, Principles of Industrial Instrumentation, Tata McGraw-Hill Publishing Ltd., New Delhi, 2010. **Web References:** 1. https://www.festo.com/in/en/ 2. https://www.mitsubishielectric.com/en/index.html 3. https://archive.nptel.ac.in/courses/112/106/112106300/

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME351.1	Recognize the various concepts of fluid power and PLC systems.
R19ME351.2	Comprehend functions of fluid power and PLC systems.
R19ME351.3	Explain the various standard fluid power circuits, functions, communication and IO details of PLC.
R19ME351.4	Demonstrate the standard fluid power circuits and PLC based interfaces.
R19ME351.5	Construct the fluid power circuits and PLC based automation system.

R19AM312	Artificial Intelligence and Machine Learning Laboratory	L	T	P	C
		0	0	4	2

1. Course Description:

This course offers a comprehensive exploration of the foundational principles and core concepts in Artificial Intelligence (AI). Beginning with an introduction to the history and applications of AI, the course progressively delves into intelligent agents, problem-solving, search algorithms, and extends to encompass knowledge representation and planning. Machine learning is a branch of artificial intelligence that enables systems to learn from data and improve their performance over time without being explicitly programmed. Students will gain a solid understanding of various machine learning algorithms, their theoretical underpinnings, and how to apply them both artificial intelligence and machine learning to real-world problems.

2. Course Objectives:

1. To study about structure of agents and the nature of environments
2. To learn the search algorithms of AI in different environments
3. To Learn and apply adversarial search techniques to solve problems in dynamic environments.
4. To understand the basic concepts of machine learning.
5. To understand and build supervised learning models.
6. To understand and build unsupervised learning models.

3. List of Laboratory Experiments / Exercises:

1. Identify and discuss the distinctive features that set PROLOG apart as a declarative programming language. Break down the essential elements, delving into the role of facts, rules, and queries. Examine how these components work together to facilitate logical reasoning.
2. Imagine you are working on an AI system for an automated chessboard configuration. One of the challenges is placing four queens on a 4x4 chessboard in such a way that no two queens threaten each other. Provide the Prolog code and demonstrate the solution by showing the positions of the queens on the 4x4 grid.
3. Imagine a scenario in a computer game where a character needs to navigate through various cities to complete a quest. The goal is to design a Prolog program that solves the Traveling Salesman

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Problem for the character, finding the optimal route to visit each city exactly once and return to the starting point while minimizing the total distance traveled. The cities in the game are connected by different types of paths, each with its own associated cost.

4. Assume you are playing the Pac-Man game where the maze is represented as a grid with Pac-Man, ghosts, walls, and empty spaces. Implement Breadth-First Search (BFS) for Pac-Man navigation, considering the presence of ghosts as obstacles in the exploration process.
5. Imagine a Real-Time Strategy game (Age of Empires) where you command a battalion of futuristic units navigating a dynamic battlefield. The terrain is diverse, including open fields, mountains, and urban areas. Your mission is to implement the A* search algorithm for unit path finding, considering the real-time movements of enemy units and dynamically changing obstacles. Describe how you would model the game environment as a grid, incorporating varying traversal costs for different terrains. Discuss the heuristic function you would employ to guide unit movements, considering factors such as the proximity of enemies, defensive structures, and the goal of reaching specific objectives on the map.
6. Implement the Alpha-Beta Pruning algorithm to determine the best move for a player in a Tic-Tac-Toe game tree. The game tree must represent all possible moves and countermoves, creating an extensive search space.
7. Demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
8. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
9. Implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
10. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Libraries can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
11. Construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.
12. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using K Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering.

References:

Reference Books:

1. Deepak Khemani, “A First Course in Artificial Intelligence”, McGraw Hill Education, New Delhi, 2017
2. Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AM312.1	Implement a study of agents' structures and diverse environments in AI.
R19AM312.2	Apply various AI search algorithms for different environmental scenarios using the knowledge and skills acquired.
R19AM312.3	Implement a comprehensive study of adversarial search techniques and resolving constraint satisfaction problems in AI.
R19AM312.4	Apply logical and probabilistic inference mechanisms to improve decision-making in AI systems.
R19AM312.5	Analyze knowledge representation techniques and planning algorithms vital for Artificial Intelligence

R19ME314	Computer Aided Simulation and Analysis Laboratory	L	T	P	C
		0	0	2	1

1. Course Description:

Computer Aided Simulation and Analysis Laboratory offers a comprehensive course exploring ANSYS basics and practical applications in stress analysis, thermal stress analysis, heat transfer analysis, mode frequency analysis, harmonic analysis, truss analysis and MATLAB basics to solve simple problems in vibration.

2. Course Objectives:

1. To analyze the various mechanical components in both static conditions
2. To impart the students with necessary computer aided analysis skills.
3. To analyze the various mechanical components in the dynamic conditions.
4. Simulation of mechanical components by visualization software's.
5. To impart the knowledge on program-based simulation for solving the problems.

3.List of Experiments

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of MATLAB to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software
4. Stress analysis of a plate with a circular hole & rectangular L bracket
5. Stress analysis of an axi-symmetric component
6. Stress analysis of beams (Cantilever, simply supported, Fixed ends)
7. Modal analysis of a 2 D component
8. Modal analysis of beams (Cantilever, simply supported, Fixed ends)
9. Thermal stress analysis / Harmonic analysis of a 2D piping system
10. Conductive/Convective heat transfer analysis of a 2D piping system

References:

Reference Books:

5. The Mathworks, Inc, The student Edition of Matlab, student Edition, The MATLAB curriculum series, 1997
6. RudraPratap, Getting started with MATLAB, 1st Edition, Oxford University Press, 2010

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Video References:

1. https://www.youtube.com/watch?v=-6yJS13KB8Y
2. https://www.youtube.com/watch?v=1dvEmK6To7M
3. https://www.youtube.com/watch?v=CgH3AUe6KMw

4. Course Outcomes :

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME212.1	(Apply)Utilize the analysis software for stress analysis of Mechanical components.
R19ME212.2	(Analyze)Estimate the natural frequency of 2D component
R19ME212.3	(Evaluate)Predict the dynamic characteristics of 2D components and piping system
R19ME212.4	(Analyze) Analyze the mode of heat transfer in piping system
R19ME212.5	(Create)Make use of CAD software to simulate mechanical systems

		L	T	P	C
R19ME381	**Innovative / Multi-Disciplinary Project**	**0**	**0**	**2**	**1**

1. Course Description:

Mechanical projects offer a hands-on approach to applying physics, engineering, and design principles to develop innovative solutions for sustainable development. These projects leverage tools, machines, and materials to create functional devices addressing real-world challenges, aligning with SDGs. SDG 9 (Industry, Innovation, and Infrastructure), Robotics, automotive design, aerospace engineering, and manufacturing technology projects promote industrial innovation and infrastructure development.-SDG 12 (Responsible Consumption and Production), Projects focusing on efficient resource utilization, sustainable manufacturing, and waste reduction contribute to responsible consumption and production patterns.SDG 4 (Quality Education),Mechanical projects enhance STEM education, fostering critical thinking, problem-solving, and creativity.

2. Course Objectives:

1. To help the students to develop the ability to solve a specific problem right from its identification.
2. To conduct literature review till the successful solution of the same,
3. To train the students in preparing project reports and to face reviews and viva voce examination.

3. Syllabus

To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted

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by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME381.1	Understand the concepts of basic and advancements of engineering
R19ME381.2	Apply the engineering concepts to identify the problems
R19ME381.3	Analyse the complex challenging problem in the field of engineering
R19ME381.4	Create the new ideas or methodology to find the solution of the problem
R19ME381.5	Evaluate the understanding based on the oral presentation and report preparation.

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Professional Elective Courses

VERTICAL 1- ROBOTICS AND AUTOMATION

R19ME511	Sensors and Instrumentation	L	T	P	C
		3	0	0	3

1.Course Description:

This course provides a comprehensive exploration of to understand the concepts of measurement technology. It focuses on the various sensors used to measure various physical parameters and the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development. Course discuss about the optical, pressure and temperature sensor. The course explores how to understand the signal conditioning and DAQ systems.

2. Course Objectives:

5. To understand the concepts of measurement technology.
6. To learn the various sensors used to measure various physical parameters.
7. To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
8. To learn about the optical, pressure and temperature sensor
9. To understand the signal conditioning and DAQ systems

3. Syllabus

Unit-I: Introduction

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

Unit-II: Motion, Proximity and Ranging Sensors

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

Unit-III: Force, Magnetic and Heading Sensors

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

Unit-IV: Optical, Pressure and Temperature Sensors

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

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Unit-V: Signal Conditioning and DAQ Systems
Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring
Text Books:
5. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009. 6. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpati Rai & Co, 12th edition New Delhi, 2013.
Reference Books:
1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada,2001. 2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001. 3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications,1999. 4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011 5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME511.1	(Apply) Recognize with various calibration techniques and signal types for sensors.
R19ME511.2	(Analyze) Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
R19ME511.3	(Analyze) Apply the various sensors and transducers in various applications.
R19ME511.4	(Apply) Select the appropriate sensor for different applications.
R19ME511.5	(Analyze) Acquire the signals from different sensors using Data acquisition systems.

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R19ME512	Electrical Drives And Actuators	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides fundamental knowledge into relay and semiconductor devices, including BJT, SCR, MOSFET, IGBT, and more. It also covers motor dynamics, DC and AC motor operations, including speed control methods. Additionally, it explores stepper motors, servo mechanisms, and their diverse applications across electrical engineering disciplines.

2. Course Objectives:

6. Gain insight into the operation and applications of various semiconductor devices like BJT, SCR, MOSFET, etc
7. Learn about motor load dynamics equations and multi-quadrant dynamics for efficient electric drive system design.
8. Develop skills in controlling DC and AC motors, including DC servomotors and 3-phase induction motors, for diverse industrial applications.

3. Syllabus

Unit-I: Relay and Power Semi-Conductor Devices

Study of Switching Devices: Relay and Types; Switching characteristics: BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT; SCR, MOSFET and IGBT; Triggering and commutation circuit; Introduction to Driver and snubber circuits

Unit-II: Drive Characteristics

Electric drive: Equations governing motor load dynamics, steady state stability; Multi quadrant Dynamics: acceleration, deceleration, torque and Direction starting & stopping; Selection of motor.

Unit-III: DC Motors and Drives

DC Servomotor: Types of PMDC & BLDC motors, principle of operation, emf and torque equations, characteristics and control; Drives: H bridge, Single and Three Phases; 4 quadrant operation; Applications.

Unit-IV: AC Motors and Drives

Introduction to Induction motor drives; Speed control of 3-phase induction motor: Stator voltage control, Stator frequency control, Stator voltage and frequency control, Stator current control, Static rotor resistance control, Slip power recovery control.

Unit-V: Stepper and Servo Motor

Stepper Motor: Classifications, Construction and Principle of Operation; Modes of Excitation Drive System: Logic Sequencer, Applications. Servo Mechanism: DC Servo motor, AC Servo motor, Applications.

Text Books:

3. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
4. Mehta V.K. &Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand

& Co. Ltd., New Delhi, 2016
Reference Books:
4. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001. 5. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME512.1	Recognize the principles and working of relays, drives and motors
R19ME512.2	Explain the working and characteristics of various drives and motors.
R19ME512.3	Apply the solid state switching circuits to operate various types of Motors and Drivers.
R19ME512.4	Interpret the performance of Motors and Drives
R19ME512.5	Suggest the Motors and Drivers for given applications.

R19ME513	**Embedded Systems and Programming**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

In the rapidly growing digital world, role of embedded systems is increasingly vital in various domains such as industrial and home automation, entertainment systems, medical equipment and many more. The core of all such system is powered by electronic hardware and associated software. It is therefore evident to impart the knowledge of the related technology and hands on skills to develop and maintain electronics hardware based embedded systems.

2. Course Objectives:

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments.

3. Syllabus

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Unit-I: Introduction to Microcontroller
Fundamentals: Functions of ALU; Microprocessor; Microcontrollers: CISC and RISC; Types of Microcontroller; 8051 Family: Architecture, Features and Specifications; Memory Organization; Instruction Sets; Addressing Modes.
Unit-II: Programming and Communication
Fundamentals of Assembly Language Programming; Instruction to Assembler: Compiler and IDE; C Programming for 8051 Microcontroller: Basic Arithmetic and Logical Programming; Timer and Counter; Interrupts; Interfacing and Programming of Serial Communication, I^2C, SPI and CAN of 8051 Microcontroller: Bluetooth and WI-FI interfacing of 8051 Microcontroller.
Unit-III: Peripheral Interfacing
I/O Programming: Interfacing of Memory, Key Board and Displays; Alphanumeric and Graphic; RTC, interfacing of ADC and DAC, Sensors; Relays; Solenoid Valve and Heater; Stepper Motors; DC Motors; PWM Programming; Closed Loop Control Programming of Servomotor; Traffic Light.
Unit-IV: Arm Processor
Introduction ARM 7 Processor; Internal Architecture; Modes of Operations; Register Set; Instruction Sets; ARM Thumb; Thumb State Registers; Pipelining; basic programming of ARM 7; Applications.
Unit-V: Single Board Computers and Programming
System on Chip; Broadcom BCM2711 SoC; SBC architecture; Models and Languages; Embedded Design; Real Time Embedded Operating Systems; Real Time Programming Languages; Python for Embedded Systems; GPIO Programming; Interfacing **Total: 45 Hours**
Text Books:
1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley. **2.** Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003
References:
Reference Books: 1. Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006. 2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition,2015 3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003. 4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME513.1	**(Understand)** Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.
R19ME513.2	**(Understand)** Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications.
R19ME513.3	**(Apply)** Interface the sensors, actuators and other I/O's with microcontroller, processors and system-on-chip based interfacing
R19ME513.4	**(Analyze)** Design the circuit and write the programming microcontroller, processors and system-on-chip
R19ME513.5	**(Create)** Develop the applications using Embedded system.

R19ME514	Collaborative Robotics	L	T	P	C
		3	0	0	3

1. Course Description:

The course covers cobotics fundamentals, including collaborative robotics and modern mobile robots. It delves into Swarm Robotics, Modular Robotics, and Naturally Inspired Collaboration, before exploring reconfigurable robots and formation control. Students gain insights into theoretical models and practical applications, preparing them for challenges in the field.

2.Course Objectives:

1. To know the fundamentals of Collaborative Robotics
2. To introduce Swarm robot and trajectory planning for Swarm
3. To introduce Modular Robotics and its Mechanics
4. To learn about various Natural models of robot collaboration
5. To introduce the concept of Reconfigurable robot

3.Syllabus

Unit-I: Introduction to Cobotics

Collaborative Robotics: Properties; Introduction to Modern Mobile Robots: Swarm Robots, Cooperative and Collaborative Robots, Mobile Robot Manipulators; Current Challenges.

Unit-II: Swarm Robotics

Introduction; mapping: kinematics and trajectory error compensation, state transitions, collective decision making and methodologies, swarm robot scenarios, aggregation, clustering dispersion, pattern formation, sorting, flocking and collective motion, shepherding, heterogeneous swarms, Error Detection and Security.

Unit-III: Modular Robotics

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Module Designs: Modular Robot Representation, Modular Serial Robot Kinematics; Kinematic Calibration for Modular Serial Robots; Modular Serial Robot Dynamics; Modular Parallel Robot Kinematics.
Unit-IV :Naturally Inspired Collaboration
Collective Decision Making: Group Decision Making in Animals, Collective Motion as Decision Process; Models for Collective Decision Making Processes: Urn Models, Voter Model, Majority Rule, Hegselmann and Krause, Kuramoto Model, Axelrod Model, Ising Model, Fiber Bundle Model, Sznajd Model, Bass Diffusion Model, Sociophysics and Contrarians.
UNIT – V Reconfigurable Robots
V Shaped Formation Control for Robotic Swarms: Constrained by Field of View, formation of reconfigurable virtual linkage; Reconfigurable Formation Control of Multi Agents; Self Assembly Modular Robot Platform Based on Sambot; Swarm Dynamics Emerging from Asymmetry; Applications of reconfigurable Robots
Text Books:
1. Guilin Yang, I-Ming Chen, "Modular Robots: Theory and Practice", Springer, 2022. 2. Giandomenico Spezzano, "Swarm Robotics", Applied Sciences, MDPI, 2019.
References:
Reference Books: 1. Heiko Hamann, "Collective Decision-Making in Swarm Robotics: A Formal Approach", Springer, 2019. **Web References:** **4.** https://campaign.abb.com/l/501021/2020-08-12/rw1ysc 5. https://www.coursera.org/learn/collaborative-robot-safety

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME514.1	Understand the fundamentals of Collaborative Robotics
R19ME514.2	Understand Swarm robot and trajectory planning for Swarm
R19ME514.3	Understand the concept Modular Robotics and its Mechanics
R19ME514.4	Analyse various Natural models for robot collaboration
R19ME514.5	Understand concept of Reconfigurable robot

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R19ME515	Robot Kinematics and Dynamics	L	T	P	C
		3	0	0	3

1. Course Description:

Robot Kinematics and Dynamics is a comprehensive course designed to provide students with a deep understanding of the mathematical principles and analytical tools essential for modeling and analysing the motion of robotic systems. This course delves into both theoretical concepts and practical applications, equipping students with the knowledge and skills necessary to design, control and optimize robotic mechanisms. Throughout the course, students will explore the fundamental concepts of robot kinematics, including forward and inverse kinematics. They will learn how to represent geometric and algebraic relationships to describe the motion of robotic manipulators accurately. The course also covers robot dynamics, focusing on topics such as Newton-Euler equations, Lagrangian mechanics, and dynamics modelling.

2. Course Objectives:

1. To understand Robots history, terminologies, classification and configurations.
2. To get knowledge about advanced forward and inverse kinematics approaches to solve multi-DOF robot manipulators.
3. To apply Lagrangian and Hamiltonian mechanics to solve robot dynamic problems.

3. Syllabus

Unit-I: Overview of Robotics

Robotics: History, Definitions, Law of Robotics, Terminologies, Classifications, Links & Joints, Degrees of Freedoms, Coordinate Systems, Work Volume, Precision, Repeatability & Accuracy; Position and Orientation of Objects; Roll, Pitch and Yaw Angles; Joint Configuration: Five Types of Serial Manipulators; Wrist Configuration; Overview of end effector; Selection and Application of Serial Manipulators.

Unit-II: Forward Kinematics - Geometrical and Algebraic Approach

Need for forward and Inverse Kinematics Equation; Parameters in Design and Control; Methods of forward and inverse kinematics; Geometrical and Algebraic Approach in Forward Kinematics Solution: 1 DOF, 2 DOF Planar Robot (2P and 2R), 3DOF 2RP Spatial Robot.

Unit-III: Forward Kinematic modelling – Denavit-Harteberg (DH) Approach

Unit Circle Trigonometry; Translation Matrix; Rotation matrix; Euler Angles; Quaternion Fundamental; Dot and Cross Products; Frames and Joint Coordinates; Homogeneous Transformation: D-H and Modified D-H Convention and Procedures; Forward kinematics Solution using D-H Convention: 3 DOF wrist, RR Planar, 3 DOF RRP, Cartesian, Cylindrical, Spherical , SCARA& Articulated 3 DOF robots, 3 DOF robot with wrist.

Unit-IV: Inverse Kinematics Modelling

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Inverse kinematics: Introduction, Issues in inverse kinematics; Inverse kinematics: 2 DOF Planar robot, 2 and 3DOF planar & Spatial robot, 3 axis robot & 6 axis Robot (Closed loop solution); Tool configuration.
Unit-V: Robot Dynamics
General Expressions for Kinetic and Potential Energy; Kinetic Energy for an n-Link Robot; Potential Energy for an n-Link Robot; Equations of Motion; Lagrangian Multiplier; Langrage's Equation; Hamilton Equation; Hamilton vector Field; Euler - Langrage Equation; State Vector and Equation Formulation.
Text Books:
1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012. 2. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005
References:
1. Lynch, Kevin M., and Frank C. Park. Modern Robotics: Mechanics, Planning, and Control 1st ed. Cambridge University Press, 2017. 2. S K Saha, Introduction to Robotics, Tata McGraw-Hill, Second Edition, 2017. 3. Arthor Critchlow, "Introduction to Robotics", 1st edition, Macmillan, 2009. 4. Deb S.R., "Robotics Technology and Flexible Automation", 2nd edition, Tata McGraw – Hill Publis Robotics: Control and Programming. 5. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, Prentice Hall of India Pvt. Ltd., 2001 **NPTEL/Online Courses:** 4. https://nptel.ac.in/courses/112105236 5. https://archive.nptel.ac.in/courses/112/105/112105236/ 6. https://nptel.ac.in/courses/112105249

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME515.1	Explain the history, classifications, and basic terminologies of robotics and various configuration of robots.
R19ME515.2	Analyze forward kinematic model for planar and spatial robot manipulator.
R19ME515.3	Analyze forward kinematic model for multi-DOF robot manipulators.
R19ME515.4	Analyze inverse kinematic model for multi-DOF robot manipulators
R19ME515.5	Analyze the static force model and inverse dynamic model of multi-degree of freedom (DOF) manipulator using Lagrangian and Hamiltonian mechanics.

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R19ME516	Drone Technologies	L	T	P	C
		3	0	0	3

1. Course Description:

The course covers the breadth of Drone Technology, from conceptual understanding and design fabrication to practical flying operations and commercial applications. Students explore drone functionalities, flight modes, and programming techniques, while also delving into sectors like insurance, delivery, agriculture, and infrastructure inspection. Additionally, safety measures, regulatory frameworks, and future trends such as miniaturization and swarm utilization are discussed to provide a comprehensive overview of the field.

2.Course Objectives:

- To understand the basics of drone concepts
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

3.Syllabus

Unit-I: Introduction to Drones

History of UAV; UAV rules: International, national; DGCA notification of regulations for civil use; Drone Rules 2021: Definitions, classification, operation, zones, procedure, requirements, forms; DGCA-DTC: Notification, amendments; Drone Operations through digital platform; Enforcement actions; UAV impact on the business; Drone business: Opportunities, employability, entrepreneurship.

Unit-II: Flight basics

Types of UAV; Principles of flight; Forces acting on airplane; Physical properties and structure of the atmosphere; METAR; Anatomy of flight; Aerodynamics; Aerofoil nomenclature and characteristics; Propulsion and airplane structure; Flight maneuvers; Radio telephony.

Unit-III: UAV Components and Sensors

Classifications of drone based on structures and their suitability; Components: Frames, motors, propellers, electronic speed controllers, flight controller, Payload and Payload mechanism. Sensors: IMU, GPS, imaging cameras and its types, LiDAR, SAR, ultrasonic detectors; Drone communication; RF, WIfi; GCS; Navigation and Guidance system; Mission planning and control.

Unit-IV: Design of UAV

Design loop; Selection of hardware components; Aerodynamics and airframe configurations; Design standards and regulatory aspects; Introduction to CAD & CAE; Aerodynamic analysis using CFD; Design of UAV components using 3D printing.

Unit-V: Applications

Application beneficial drones: Aerial photography, mapping and surveying, agriculture, logistics, power sector, mines; search and rescue, infrastructure inspection, conservation, defense; Swarm drones; Miniaturization of drones; Case study.

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Text Books:
1. 1.Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and 2. Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc. 3. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016
References:
Reference Books: 1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016 2. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018. **3.** DGCA - Drone rules 2021 and DTC's **4.** Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc. **5.** Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016. **6.** Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010. 7. Paul Gerin Fahlstrom, Thomas James Gleason "Introduction to UAV Systems", Fourth Edition, First published:24 August 2012 Print ISBN:9781119978664 |Online ISBN:9781118396780 |DOI:10.1002/9781118396780. **8.** Kimon P. Valavanis, George J. Vachtsevanos, "Handbook of Unmanned Aerial Vehicles, Newyork, springer, Boston, Massachusetts: Credo Reference 2016. **Web Resources :** **1.** https://www.coursera.org/courses?query=drone

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME516.1	Know about a various type of drone technology
R19ME516.2	Obtain a knowledge about design, fabrication and programming in drone
R19ME516.3	Learn about the flying and operation of drone
R19ME516.4	Knowledge about the various commercial application of drone
R19ME516.5	Understand the safety risks and guidelines to fly safely

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R19ME517	Industry 4.0	L	T	P	C
		3	0	0	3

1.Course Description:

This course provides a comprehensive exploration of Industry 4.0, focusing on digitalization, IoT, and their integration into various industries. Beginning with an overview of Industry 4.0 concepts and its comparison with traditional factories, it delves into IoT protocols, middleware, and security. Integrated IoT solutions and their business applications are examined, alongside case studies in manufacturing, automation, and resource management. The course explores how Industry 4.0 affects businesses and strategies they can use to thrive in this new era of industry.

2. Course Objectives:

1. Understand the fundamental concepts of Industry 4.0 and its impact on modern factories and industries.
2. Explore the role of IoT and its protocols in creating interconnected systems for smarter production and logistics.
3. Examine the integration of IoT into various industries and its implications for business models and operations.
4. Analyze real-world applications of Industry 4.0, such as in car manufacturing, electronics, and agriculture.
5. Discuss the challenges and opportunities posed by Industry 4.0 and develop strategies for businesses to thrive in this evolving landscape.

3.Syllabus

Unit-I: Industry 4.0

Digitalization and the Networked Economy; Introduction to Industry 4.0: Comparison of Industry 4.0 Factory and Today's Factory; Internet of Things (IoT): Industrial Internet of Things (IIoT), Smart Devices and Products, Smart Logistics; Support System for Industry 4.0; Cyber-physical Systems Requirements; Data as a New Resource for Organizations; Cloud Computing; Trends of Industrial Big Data and Predictive Analytics for Smart Business; Architecture of Industry 4.0.

Unit-II: IoT and its Protocols

Definitions and Functional Requirements: Motivation, Architecture, Web 3.0 View of IoT, Ubiquitous IoT Applications .Four Pillars of IoT; DNA of IoT; The Toolkit approach for End-User Participation in the Internet of Things. Middleware for IoT: Overview, Communication, Middleware for IoT, IoT Information Security. IIoT Reference Architecture; Designing Industrial Internet Systems; Access Network Technology and Protocols Standardization for IoT, Efforts; M2M and WSN Protocols; SCADA and RFID Protocols; Issues with IoT Standardization; Unified Data Standards; Protocols: IEEE 802.15.4, BAC Net Protocol; Modbus: KNX, ZigBee Architecture, Network layer APS layer, Security.

Unit-III: Integrated IoT

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things; Network Dynamics: Population Models, Information Cascades, Network Effects. Network Dynamics: Structural Models, Cascading Behaviour in Networks, The Small-World Phenomenon

Unit-IV: Applications

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The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments; Resource Management in the Internet of Things: Clustering, Synchronization and Software Agents; Industry 4.0 in Car Manufacturing: Electronics Manufacturing, IOT Based Building Automation, Agricultural Automation.
Unit-V: Business Issues in Industry 4.0
Opportunities and Challenges; Future of Works and Skills for Workers in the Industry 4.0 Era ; Strategies for competing in an Industry 4.0 world.
Text Books:
1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things, APress, 2016. 2. Duato J, Yalamanchili S, and Lionel Ni, "Interconnection Networks: An Engineering Approach", Morgan Kaufmann Publishers, 2004.
Reference Books:
1. Kiran Kumar Pabbathi, "Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0", Create space Independent Publishing Platform, 2018. 2. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, —Handbook of Industry 4.0 and SMART Systems‖ Taylor and Francis,2020

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME517.1	Understand Industry 4.0 concepts, including digitalization and IoT, and their impact on modern factories.
R19ME517.2	Apply IoT protocols and middleware to design efficient production and logistics systems.
R19ME517.3	Evaluate IoT integration into industries and its effects on business models and operations.
R19ME517.4	Analyze Industry 4.0 case studies to identify best practices and challenges.
R19ME517.5	Develop strategic approaches for businesses to thrive in the Industry 4.0 era, considering workforce

R19ME518	Digital Twin and Industry 5.0	L	T	P	C
		3	0	0	3
1. Course Description:					
This course explores the concept, applications, and technologies enabling Digital Twin implementation in various industries. Students delve into the role of Digital Twin in discrete and process industries, focusing on product and plant simulations, data analysis, and automation. The course concludes with an examination of Industry 5.0 principles, benefits, challenges, and the advantages of Digital Twin in enhancing product quality, process safety, and production efficiency.					

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2.Course Objectives:

1. To understand the basics concepts in digital twin
2. To Introduce the concepts in digital twin in a discrete Industry
3. To Introduce the concepts in digital twin in a process Industry
4. To obtain the knowledge in industry 5.0
5. To know about the advantages in industry 5.0

3.Syllabus

Unit-I: Introduction

Digital twin: Definition, types of Industry and its key requirements, Importance, Application of Digital Twin in process, product, service industries; History of Digital Twin; DT role in industry innovation; Technologies/tools enabling Digital Twin – Virtual CAD Models, control Parameters, Real time systems, control Parameters, Handshaking Through Internet, cyber physical systems

Unit-II: Digital Twin in a Discrete Industry

Basics of Discrete Industry, Trends in the discrete industry, control system requirements in a discrete industry, Digital Twin of a Product, Digital Thread in Discrete Industry, Data collection & analysis for product & production improvements, Automation simulation, Digital Enterprise

Unit-III: Digital Twin in a Process Industry

Basics of Process Industry, Trends in the process industry, control system requirements in a process industry, Digital Twin of a plant, Digital Thread in process Industry, Data collection and analysis for process improvements, process safety, Automation simulation, Digital Enterprise

Unit-IV: Industry 5.0

Industry 5.0: Definition, principles, Application of Industry 5.0 in process & discrete industries, Benefits of Industry 5.0, challenges in Industry 5.0, Smart manufacturing, Internet of Things 5.0, Industrial Gateways; Basics of Communication requirements, cognitive systems 5.0.

Unit-V: Advantages of Digital Twin

Improvement in product quality, production process, process Safety, identify bottlenecks and improve efficiency, achieve flexibility in production, continuous prediction and tuning of production process through Simulation, reducing the time to market.

Text Books:

1. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2018
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019

References:

1. Uthayan Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2022.

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2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress., United States ,2015.
3. Christoph Jan Bartodziej, "The Concept Industry 4.0 an Empirical Analysis of Technologies and Applications in Production Logistics", Springer Gambler., Germany, 2017.
4. Ibrahim Garbie, "Sustainability in Manufacturing Enterprises, Concepts, analyses and assessments for Industry 4.0", Springer., Switzerland, 2016.
5. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018
6. Ulrich Sendler, "The Internet of Things, Industries 4.0 Unleashed", Springer., Germany, 2018

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME518.1	Analyze the basics concepts in digital twin
R19ME518.2	Recognize the concepts in digital twin in a discrete Industry
R19ME518.3	Recognize the concepts in digital twin in a process Industry
R19ME518.4	Obtain the knowledge in industry 5.0
R19ME518.5	Apply the advantages in industry 5.0 with various applications

VERTICAL 2- SMART MOBILITY SYSTEMS

		L	T	P	C
R19ME521	**AUTOMOBILE ENGINEERING**	**3**	**0**	**0**	**3**

1.Course Description:

Automotive engineering is one of the most sophisticated courses in engineering which involves design, manufacturing, modification and maintenance of an automobile such as buses, cars, trucks and other transportation vehicles.

2. Course Objectives:

1. To study the construction and working principle of various parts of an automobile.
2. To study the practice for assembling and dismantling of engine parts and transmission system
3. To study various transmission systems of automobile.
4. To study about steering, brakes and suspension systems
5. To study alternative energy sources

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3.Syllabus
Unit-I: Vehicle Structure and Engines
Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines: components, functions and materials; variable valve timing (VVT).
Unit-II: Engine Auxiliary Systems
Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).
Unit-III: Transmission Systems
Clutch: types and construction; gear boxes: manual and automatic, gear shift mechanisms; Overdrive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.
Unit-IV: Steering, Brakes and Suspension Systems
Power Steering : Steering geometry, types of steering gear box; Suspension Systems : Types of Front Axle, Types of Suspension Systems; Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronic brake force distribution (EBD) and Traction Control.
Unit-V: Alternative Energy Sources
Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles, Engine modifications required and Performance; Combustion and Emission Characteristics of SI and CI engines with these alternate fuels : Electric and Hybrid Vehicles; Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.
Text Books:
1. Jain K.K. and Asthana. R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002. 2. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.
Reference Books:
1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2012 2. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME521.1	**(Apply)** Recognize the various parts of the automobile and their functions and materials.
R19ME521.2	**(Understand)** Discuss the engine auxiliary systems and engine emission control.
R19ME521.3	**(Analyze)** Distinguish the working of different types of transmission systems.
R19ME521.4	**(Understand)** Explain the Steering, Brakes and Suspension Systems
R19ME521.5	**(Analyze)** Predict possible alternate sources of energy for IC Engines

R19ME522	Electric And Hybrid Vehicles	L	T	P	C
		3	0	0	3

1.Course Description:

This course will provide a broad technical knowledge about hybrid and electric vehicle (HEV) architectures, modelling, sizing, and sub system design and hybrid vehicle control.

2. Course Objectives:

1. To study the architecture and operation involved in electric and hybrid vehicles.
2. To study the non-conventional energy sources like battery and fuel cell.
3. To study the parameters in selecting electric motor for electric and hybrid application.
4. To study about power electronics in electric and hybrid applications.
5. To study the design requirements for electric and hybrid vehicle.

3.Syllabus

Unit-I: Design Considerations For Electric Vehicles

Need for Electric vehicle; Comparative study of diesel, petrol, hybrid and electric Vehicles; Advantages and Limitations of hybrid and electric Vehicles; Design requirement for electric vehicles: Range, maximum velocity, acceleration, power requirement, mass of the vehicle; Various Resistance; Transmission efficiency; Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

Unit-II: Energy Sources

Battery Parameters; Different types of batteries: Lead Acid, Nickel Metal Hydride, Lithium ion, Sodium based and Metal Air; Battery Modelling: Equivalent circuits, Battery charging, Quick Charging devices; Fuel Cell: Fuel cell Characteristics, Fuel cell types, Half reactions of fuel cell; Ultra capacitors; Battery Management System.

Unit-III: Motors And Drives

Types of Motors: DC motors, AC motors, PMSM motors, BLDC motors, Switched reluctance motors; working principle, construction and characteristics.

Unit-IV: Power Converters And Controllers
Solid state Switching elements and characteristics: BJT, MOSFET, IGBT, SCR and TRIAC; Power Converters: rectifiers, inverters and converters; Motor Drives: DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors; four quadrant operations. operating modes.
Unit-V: Hybrid And Electric Vehicles
Main components and working principles of a hybrid and electric vehicles; Different configurations of hybrid and electric vehicles; Power Split devices for Hybrid Vehicles: Operation modes; Control Strategies for Hybrid Vehicle; Economy of hybrid Vehicles: Case study on specification of electric and hybrid vehicles.
Text Books:
1. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003 2. Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005.
Reference Books:
1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003. 2. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME522.1	**(Understand)** Explain the operation and architecture of electric and hybrid vehicles
R19ME522.2	**(Apply)** Identify various energy source options like battery and fuel cell
R19ME522.3	**(Analyze)** Select suitable electric motor for applications in hybrid and electric vehicles.
R19ME522.4	**(Understand)** Explain the role of power electronics in hybrid and electric vehicles
R19ME522.5	**(Analyze)** Examine the energy and design requirement for hybrid and electric vehicles.

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R19ME523	Automotive Electronics	L	T	P	C
		3	0	0	3

1.Course Description:

Automotive Electronics covers electrical systems, sensors, control units, and communication networks in vehicles, integrating advanced technology crucial for modern automotive design and functionality.

2. Course Objectives:

1. To study the common type of sensors used in Automotive Vehicles
2. To study the diversified actuators used in Automotive Vehicles
3. To design measuring instruments for controlling the parameters in Automotive Vehicles.
4. To develop new ideas in designing the sensor and actuators for Automotive Application.

3.Syllabus

Unit-I: Introduction To Measurements And Sensors

Sensors: Functions, Classifications, Main technical requirement and trends, Units and standards; Calibration methods: Classification of errors, Error analysis, Limiting error, Probable error, Propagation of error, Odds and uncertainty; Principle of Transduction: Classification; Static characteristics; mathematical model of transducers: Zero, First and Second order transducers; Dynamic characteristics of first and second order transducers for standard test inputs.

Unit-II: Variable Resistance And Inductance Sensors

Principle of operation; Construction details: Characteristics and applications of resistive potentiometer, Strain gauges, Resistive thermometers, Thermistors, Piezo resistive sensors, Inductive potentiometer; Variable reluctance transducers: EI pick up and LVDT.

Unit-III: Variable And Other Special Sensors

Variable air gap type, variable area type and variable permittivity type; capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor; digital transducers; Humidity Sensor; Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

Unit-IV: Automotive Actuators

Electromechanical actuators; Fluid-mechanical actuators; Electrical machines: Direct-current machines, Three-phase machines, Single-phase alternating; Current Machines: Duty-type ratings for electrical machines; Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.,

Unit-V: Automatic Temperature Control Actuators

Different types of actuators used in automatic temperature control; Fixed and variable displacement temperature control; Semi-Automatic: Controller design for Fixed and variable displacement type air conditioning system.

Text Books:

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin DhaneshN.Manik McGraw Hill Publishers, 2019

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2. Robert Brandy, " Automotive Electronics and Computer System", Prentice Hall,2001
Reference Books:
1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013 2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME523.1	**(Understand)** List common types of sensor and actuators used in vehicles.
R19ME523.2	**(Apply)** Design measuring equipment's for the measurement of pressure force, temperature and flow.
R19ME523.3	**(Apply)** Generate new ideas in designing the sensors and actuators for automotive application
R19ME523.4	**(Understand)** Explain the operation of the sensors, actuators and electronic control.
R19ME523.5	**(Apply)** Design temperature control actuators for vehicles.

R19ME524	Automotive System Modelling And Simulation	L	T	P	C
		3	0	0	3
1.Course Description:					
Automotive System Modelling and Simulation is a specialized course designed to provide students with a comprehensive understanding of the principles, methodologies, and tools used in modelling and simulating automotive systems. This course focuses on the application of mathematical models, computer simulations, and software tools to analyse, design, and optimize various automotive systems, components, and processes.					
2. Course Objectives:					
1. To review of the various systems and parts, such as the electrical systems, braking, steering, chassis, suspension, and powertrain, that are present in contemporary cars. 2. To introduce the computational modelling methods—such as transfer functions, state-space models, and differential equations—that are used to simulate the dynamics and performance of automotive systems. 3. To analyzing performance, fuel economy, emissions, and thermal management by modelling and simulating the behavior of internal combustion engines, transmissions, drivelines, and hybrid/electric powertrains					

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4. To designing and simulating automotive control systems, such as engine control, traction control, stability control, and adaptive cruise control, using the concepts of control theory.

3.Syllabus

Unit – I: Modelling In Performance Parameter

Acceleration Modelling: Vehicle Acceleration, Acceleration performance parameters, Modelling the acceleration of an electric scooter, Modelling the acceleration of a small car;

Unit – II: Modelling Of Battery Electric Vehicles

Vehicle Modelling: Electric Vehicle Modelling, Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling; Battery Modelling: Electric Vehicle Range, Driving cycles, Range modelling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles;

Unit – III: Drivetrain Characteristics

Drivetrain Modelling: Characteristics of EV/HEV Powertrains Components, ICE Performance Characteristics, Electric Motor Performance Characteristics; Battery Performance Characteristics: Transmission & Drivetrain Characteristics, Regenerative Braking performance;

Unit – IV: Energy Management

Vehicle Handling: Analysis of Electric& Hybrid Electric Vehicles, Simplified Handling models Energy Management: Energy/Power Allocation and Management, Power/Energy Management Controllers, Optimization based Control Strategies;

Unit – V: Vehicle Dynamic Control

Vehicle Dynamics: Electric & Hybrid Electric Vehicle Dynamics, Fundamentals of Vehicle Dynamic Control (VDC) Systems, VDC Implementation on Electric and Hybrid Vehicles;

Text Books:

1. Wei Liu," Introduction to Hybrid Vehicle System Modelling and Control" , Wiley,2013.
2. Wei Liu," Hybrid Electric Vehicle System Modelling and Control" , 2017.

Reference Books:

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003.
2. Amir Khajepour, SaberFallah and AvestaGoodarzi, "Electric and Hybrid VehiclesTechnologies, Modeling and Control: A Mechatronic Approach", John Wiley & Sons Ltd, 2014.
3. Antoni Szumanowski, "Hybrid Electric Power Train Engineering and Technology: Modeling, Control, and Simulation", IGI Global, 2013.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME524.1	**(Understand)** Familiarize the concept of electric vehicle modelling parameters.
R19ME524.2	**(Apply)** Apply the mechanical modelling of battery electric vehicles
R19ME524.3	**(Understand)** Familiarize the concept of electric motors and drives.
R19ME524.4	**(Analyze)** Analyze the power management concepts in electric motors
R19ME524.5	**(Analyze)**Analysis of vehicle dynamics using simulation

R19ME525	Vehicle Styling and Design	L	T	P	C
		3	0	0	3

1.Course Description:

This course provides a comprehensive overview of vehicle design principles and technologies, covering topics such as historical developments, mass production techniques, aerodynamics, noise and vibration control, crashworthiness, ergonomic considerations, and vehicle control systems. Students will gain insights into the design process, structural considerations, safety measures, and technological advancements essential for developing efficient and user-friendly vehicles.

2. Course Objectives:

1. To comprehend the historical development of vehicle design, including mass production methods, aerodynamic enhancements, and safety advancements.
2. To understand the principles of vehicle body design, covering styling processes, aerodynamics, and modeling techniques.
3. To analyze noise and vibration in vehicles, including measurement methods and control strategies.
4. To explore crashworthiness concepts, including accident analysis and occupant safety considerations.
5. To examine vehicle control systems, including sensor applications and safety features like ABS and airbags.

3.Syllabus

Unit-I: Introduction to Vehicle Design

Timeline developments in design; Mass production; Streamlining for style and low drag-Commercial vehicles: Engine developments, Transmission system development, Steering, Suspension, Brakes, Interior refinement and Safety design.

Unit-II: Vehicle Body Design

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The styling process: Working environment and structure, Product planning, Concept sketching and package related sketching, Full sized tape drawing, Clay modelling. Aerodynamics: Aerodynamic forces, Drag & Drag reduction, Stability during cross-winds, Wind Noise, Under-hood ventilation, Cabin ventilation. Introduction to Computational fluid dynamics; Wind tunnel testing of scale models.
Unit-III: Noise and Vibration
Vibration: fundamentals & control; Acoustics: fundamentals, Human response to sound, Sound measurement, Automotive noise criteria, Drive-by noise tests, Noise from stationary vehicles, Interior noise in vehicles; Automotive noise sources and control techniques: Engine noise, Transmission noise, Intake & exhaust noise, Aerodynamic noise, Tyre noise, Brake noise
Unit-IV: Crashworthiness and Ergonomic Approach
Accident and injury analysis; Vehicle impacts: general dynamics & crush characteristics; Structural collapse and its influence upon safety; Occupant accommodation; Ergonomics in the automotive industry; Ergonomics methods and tools; Case studies of Fiat Punto; Strategies for improving occupant accommodation and comfort.
Unit-V: Vehicle Control Systems
Automotive application of sensors: Chassis control systems, Anti-lock braking systems, Traction control systems, electronically controlled power-assisted steering, Vehicle safety and security systems, Air-bag and seat belt pre-tensioner systems, Remote keyless entry and vehicle immobilization; Introduction to On-board navigation systems.
Text Books:
1. An Introduction to Modern Vehicle Design, Julian Happian-Smith, Butterworth-Heinemann Ltd (2002)
Reference Books:
1. Aerodynamics of Road Vehicles: From Fluid Mechanics to Vehicle Engineering, Wolf-Heinrich Hucho (Eds.), Butterworth-Heinemann Ltd (1987) 2. Sensors and Transducers, Ian R Sinclair, Butterworth - Heinemann Ltd (2001) 3. The Motor Vehicle - T.K. Garrett, K. Newton & W. Steeds, Butterworth- Heinemann Ltd (2001)

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME525.1	Understand the historical evolution and key principles of vehicle design concepts.
R19ME525.2	Apply mass production techniques and safety standards in vehicle development practices.

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R19ME525.3	Analyze aerodynamic principles and their impact on vehicle performance optimization.
R19ME525.4	Evaluate noise and vibration control methods for enhanced vehicle comfort and performance.
R19ME525.5	Assess crashworthiness concepts and their implications for vehicle safety measures.

R19ME526	**Aircraft Mechatronics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description

Comprehensive overview of the technologies and equipment used in managing and mitigating pollution across various environments. Students will explore the principles and mechanisms of equipment designed for controlling water, air, and solid waste pollution. Also emphasizes the latest advancements in pollution control technology and their applications in real-world scenarios.

2. Course Objectives:

1. To provide an overview of avionics fundamentals and their significance in both civil and military aircraft.
2. To impart knowledge about the avionic architecture and various avionics data bases
3. To gain more knowledge on various avionics subsystems
4. To impart knowledge on aircraft materials and its purposes.
5. To analyse the application of Mechatronics in aircraft.

3. Syllabus

Unit-I: Aircraft Aerodynamics

Nomenclature used in Aerodynamics, different parts of airplane- Wing as lifting surface, Types of wing plan forms, Aerodynamic features like Aerofoil pressure distribution- Aerodynamic forces and moments Lift and Drag- Drag polar, L/D ratio, high lift devices, Airplane performance like Thrust/Power available, climb and glide - maximum range and endurance, take off and landings.

Unit-II: Aircraft Propulsion

Requirement of power- various means of producing power - Brief description of thermodynamics of engines - Piston engines, Jet engines - Airplane Structure, Materials and Production - Structural arrangement of earlier airplane- developments leading to all metal aircraft - Strength to weight ratio choice of aircraft materials for different parts.

Unit-III: Aircraft Materials

Detailed description of wing - tail and fuselage joints - Stress-Strain diagrams, Plane and Space, Mechanical properties of materials - Materials for different components - use of composites - Aircraft production methods and equipment. Aviation and Lighting for Cargos

Unit-IV: Primary Flight Controls

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Ailerons - Aileron Control System of a Commercial Aircraft - Elevators - Elevator control system of a commercial aircraft – Rudders- Rudder Control System
Unit-V: Applications Of Mechatronics In Aviation
Aileron-Flaps and Actuator drive unit-Pilot Static system-Fly by wire control system-Yaw damper-Primary flight control system-Internal navigation system-Under carriage-Measurement of motor rpm-Measurement of air flow velocity-Altitude measurement sensor-Air speed.
Text Books:
1. Fundamentals of Flight; By Dr. O. P. Sharma and Lalit Gupta.2006 2. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004
References books:
1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989. 2. Pallet. E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011. 3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993. 4. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME564.1	To identify and understand foundational concepts in aerodynamics, aircraft propulsion, materials, and controls
R19ME564.2	To apply Comprehend and explain different theories and principles applied in aerodynamics
R19ME564.3	To Utilize specific methods to innovate and enhance aero systems.
R19ME564.4	To integrate knowledge of aerodynamics, aircraft propulsion, materials, and controls to create aircraft designs.
R19ME564.5	To Implement aircraft systems in diverse applications.

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R19ME527	Smart Mobility And Intelligent Vehicles	L	T	P	C
		3	0	0	3

1.Course Description:

Smart Mobility and Intelligent Vehicles is a comprehensive course designed to explore the cutting-edge technologies and concepts reshaping the automotive industry and urban transportation systems. This course delves into the integration of artificial intelligence, sensor technologies, connectivity, and automation to create safer, more efficient, and sustainable mobility solutions.

2. Course Objectives:

1. To learn about the most recent developments in automation, connectivity, artificial intelligence, and sensor technologies that are transforming the urban transportation and automotive sectors.
2. To explore how vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technology for communication may improve efficiency, safety, and traffic management.
3. To acquire a solid understanding of the concepts and technology that support autonomous cars, such as decision-making systems, sensors, perception algorithms, and regulatory issues.
4. To understand how to use data analytics methods to forecast maintenance requirements, enhance operational effectiveness, and improve vehicle performance.

3.Syllabus

Unit-I: Introduction To Automated, Connected & Intelligent Vehicles

Automotive Electronics: Electronics Overview, History & Evolution, Infotainment, Body, Chassis, Powertrain Electronics; Automation: Introduction to Automated, Connected, Intelligent Vehicles; Case studies: Automated, Connected, and Intelligent Vehicles;

Unit-II: Sensor Technology For Smart Mobility

Sensors Technology; Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology, Camera Technology, Night Vision Technology, Types of sensors in vehicles, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems;

Unit-III: Connected Autonomous Vehicle

Autonomous Vehicle: Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory, Autonomous Vehicles, Role of Surroundings Sensing Systems, Role of Wireless Data Networks &Autonomy;

Unit – IV: Vehicle Wireless Technology & Networking

Vehicle Wireless System: Block Diagram, Overview of Components, Transmission Systems, Modulation, Encoding, Receiver System Concepts, Demodulation; Vehicle Networking System: Wireless Networking, Applications to Vehicle Autonomy, Basics of Computer Networking, The Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking, On-Board Vehicle Networks;

Unit – V: Connected Car & Autonomous Vehicle Technology

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Connected Car Technology: Connectivity Fundamentals, Navigation & Other Applications, Vehicle-to-Vehicle Technology, Vehicle-to-Roadside, Vehicle-to-Infrastructure; Autonomous Vehicles Technology: Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues;
Text Books:
1. Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board 2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer
Reference Books:
1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group,5th Edition,2018.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME527.1	**(Understand)** Familiarize the concept of control system of collision avoidance and autonomous vehicles
R19ME527.2	**(Apply)** Select and apply the sensor technology to implement remote sensing
R19ME527.3	**(Understand)** Familiarize the concept of wireless and autonomy vehicle.
R19ME527.4	**(Apply)** Apply the basic concepts of wireless communications and wireless data networks
R19ME527.5	**(Analyze)**Analyze the concept of the connected vehicle and its role in automated vehicles

R19ME528	Advanced Driver Assistance Systems	L	T	P	C
		3	0	0	3
1. Course Description:					
This course provides a comprehensive overview of automotive fundamentals, sensors, driver assistance technology and advanced driver assistance systems (ADAS). Students will learn about power systems, engine components and comfort systems, as well as automotive sensors and their applications. The course covers the theory of operation, integration, and examples of ADAS technology, including Lane Departure Warning, Blind Spot Detection, Autonomous Emergency Braking and Traffic Sign Recognition. Additionally, students will explore ADAS display technologies and impaired driver detection systems, preparing them for roles in automotive engineering and technology development.					
2. **Course Objectives:**					

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1. Introduce students with various fundamentals related to advanced driver assistance technologies. 2. Impart knowledge on sensors, control and actuation methodologies and create impact of automating vehicles. 3. Acquire skills on vehicle prognostics and impaired driver technology. 4. Learn about various commonly available Advanced Driver Assistance Systems. 5. Study about Center Console Technology and other display technology
3. **Syllabus**
Unit-I: Automotive Fundamentals
Power System; Running System; Comfort System; Engine Components; Drive train; suspension system; ABS; Steering System.
Unit-II: Automotive Sensors
Types (operation, types, characteristics, advantage and their applications): Knock sensors, oxygen sensors, crankshaft angular position sensor, temperature sensor, speed sensor, Pressure sensor, Mass air flow sensor, Manifold Absolute Pressure Sensors, crash sensor, Coolant level sensors, Brake fluid level sensors, Radar, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera vision technology.
Unit-III: Overview of Driver Assistance Technology
DAT: Basics, Theory of Operation, Applications, Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Vehicle Prognostics Technology.
Unit-IV: Advanced Driver Assistance Systems
Advanced Driver Assistance Systems: Lane Departure (LDW), Active Cruise Control (ACC), Blind Spot Detection, Parking Assist, Autonomous Emergency Braking (AEB), Night Vision, Traffic Sign Recognition (TSR), Intelligent High beam Assistant (IHC), Tire Pressure Monitoring (TPMS), Front Collision Warning System (FCWS), Front Vehicle Departure Warning (FVDW), Adaptive Lighting, Driver Drowsiness Detection, Hill Decent Control, Rear Cross Traffic.
Unit-V: ADAS Display & Impaired Driver Technology
ADAS Display: Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, Warning Technology-Driver Notification. Impaired Driver Technology: Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology.
Text Books:
1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & Francis Group, 5th Edition,2018. 2. William B Ribbens, "Understanding Automotive Electronic: An Engineering Perspective", Elsevier Science,8th Edition,2017.
References:
Reference Books: 1. "Intelligent Transportation Systems and Connected and Automated Vehicles", Transportation Research Board, 2016. 2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", Springer, 2019.
MOOC/SWAYAM/NPTEL Courses:

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1. https://nptel.ac.in/courses/107106088
2. https://www.udemy.com/course/advanced-driver-assistance-systems/
3. https://vit-tec.vit.ac.in/adas

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME528.1	Recognize the rational for and evolution of automotive electronics
R19ME528.2	Understand the various automotive functions, sensors and its applications
R19ME528.3	Familiarize with the theory and operation of legacy, new and emerging ADAS systems & proposed autonomous vehicle systems
R19ME528.4	Understand the fundamentals of sensor data fusion as it relates to ADAS
R19ME528.5	Apply possible evolution of vehicle prognostics and impaired driver technology

VERTICAL 3 - DESIGN AND MANUFACTURING

R19ME531	Robot and Machine Element Design	L	T	P	C
		3	0	0	3

1. Course Description

This course starts with fundamentals of mechanical design. It provides knowledge in design of links and joints and different types of bearings selections for particular applications. The concept of velocity of the links of the robots and the Jacobian matrix is developed and the associated concepts of singularities in robots are discussed in depth. The equations of motion are derived using the Lagrangian formulation and their solutions using numerical methods are presented. The course deals with types of grippers and its selection for suitable applications. Moreover, it gives knowledge in sensors and drives selection for robotics.

2. Course Objectives:

1. To introduce the students to the fundamentals of machine design, material selection and to solve the basic design problems.
2. To learn to derive various parameters for modelling links and joints in a robot
3. To learn to derive various parameters for modelling end-effectors of a robot
4. To select drives, control element and feedback devices

3. Syllabus

Unit-I: Fundamentals of Mechanical Design

Fundamentals of Machine Design: Engineering Design, Phases of Design, Design Consideration, Standards and Codes; Design against Static and Dynamic Load: Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

Unit-II: Design of Links And Joints

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Loads and Forces on Links and Joints: Design of solid and hollow shafts, Rigid and flexible couplings, Threaded fasteners, Rolling contact bearings; Links Design: Path and Motion Synthesis, Cognate Linkages, Design of Spherical Joints.

Unit-III: Design of Grippers

Grippers: Types of Grippers Mechanisms, Gripping Methods, Gripping Force analysis; Gripper Design: Two Finger gripper, Three Finger Gripper, Magnetic Gripper Design, Vacuum Gripper Design, Hooks, Scoops, Spools, Miscellaneous Grippers

Unit-IV: Robot Dynamics

General Expressions for Kinetic and Potential Energy: Kinetic Energy for an n-Link Robot, Potential Energy for an n-Link Robot, Equations of Motion, Lagrangian Multiplier, Langrage's Equation, Hamilton Equation, Hamilton vector Field, Euler Langrage Equation, State Vector and Equation Formulation.

Unit-V: Drives and Sensors

Stepper Motor: Classifications, Construction and Principle of Operation, Modes of Excitation, Drive System, Logic Sequencer, Applications; Servo Mechanism: DC Servo motor, AC Servo motor, Applications; Motion Sensors: Potentiometers, Resolver, Encoders, Optical, Magnetic, Inductive, Laser Range Sensor (LIDAR), Strain Gage, Load Cell, Magnetic Sensors, Pressure sensors and Temperature sensors.

Text Books:

1. Sharma. C.S. and Kamlesh Purohit, "Design of Machine Elements", Prentice Hall of India Private Limited, 2003
2. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.

References Books:

1. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005.
2. Robert L. Norton, "Machine Design – An Integrated Approach", Prentice Hall International Edition, 2000.
3. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2016.
4. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand& Co. Ltd., New Delhi, 2012.
5. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, "Humanoid Robots: Modelling and Control", Butterworth-Heinemann, 2018.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME531.1	State the design parameters for designing the components of a robot
R19ME531.2	Analyse the design parameters for designing the components of a robot.
R19ME531.3	Formulate the methods for designing the entire robot assembly
R19ME531.4	Design robot end effectors for various applications
R19ME531.5	Select drives, control elements and feedback devices

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R19ME532	Computer Aided Design and Manufacturing	L	T	P	C
		3	0	0	3

1. Course Description

Computer-Aided Design and Manufacturing (CAD/CAM) is an interdisciplinary course focusing on the integration of computer technology in the design and manufacturing processes. This course covers the principles, methods, and applications of CAD/CAM software systems in engineering design, analysis, simulation, and manufacturing. Through lectures, hands-on exercises, and project work, students will learn how to utilize CAD/CAM tools to create, modify, analyze, and manufacture engineering components and systems efficiently and accurately.

2. Course Objectives:

1. To Introduce and recognize the Basic of Design
2. To study the two dimensional drafting and bill of material creation.
3. To comprehend the application of computers in various aspects of Manufacturing viz., Design, Proper
4. Planning, Manufacturing cost, Layout and Material handling system.
5. To learn the basics of computer aided machining and part programming.

3. Syllabus

Unit-I: Basics of Designs

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings; Customer Specific requirements; Drawing Grid reading

Unit-II: Cad and Computer Graphics Software

Projection views: Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view; Title Block creation:BOM Creation, Notes creation,Ballooning of 2D drawing and its features for Inspection reporting; CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry; Transformations: 2D transformations, translation, rotation and scaling, homogeneous transformation matrix, concatenation, numerical problems on transformations..

Unit-III: CNC and Robot Technology

Computer Numerical Control: Introduction, components of CNC, CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems, programming with canned cycles; Cutter radius compensations. Robot Technology: Robot anatomy, joints and links, common robot configurations, robot control systems, accuracy and repeatability, end effectors, sensors in robotics; Robot programming methods: on-line and offline methods. Robot industrial applications: material handling, processing and assembly and inspection.

Unit-IV: Advanced Manufacturing and Automation

Additive Manufacturing Systems: Basic principles of additive manufacturing, slicing CAD models for AM, advantages and limitations of AM technologies, Additive manufacturing processes: Photo polymerization, material jetting, binder jetting, material extrusion, Powder bed sintering techniques, sheet lamination, direct energy deposition techniques, applications of AM; Future of Automated Factory: Industry 4.0, functions, applications and benefits; Components of Industry 4.0, Internet of Things (IOT), IOT applications in manufacturing,

Big-Data and Cloud Computing for IOT, IOT for smart manufacturing, influence of IOT on predictive maintenance, industrial automation, supply chain optimization, supply-chain & logistics, cyber-physical manufacturing systems
Unit-V: CAPP and AI
COMPUTER AIDED PROCESS PLANNING: Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.
Text Books: 1. Automation, Production Systems and Computer-Integrated Manufacturing Mikell P Groover Pearson Learning. 4th Edition,2015 2. CAD / CAM Principles and Applications P N Rao Tata McGraw-Hill 3rd Edition, 2015
References Books: 1. Ibrahim Zeid Mastering CAD CAM Tata McGraw-Hill PublishingCo.2007 2. Mikell.P.Groover Automation, Production Systems and Computer Integrated Manufacturing,Prentice Hall of India, 2008 3. Radhakrishnan P, SubramanyanS.andRaju V., CAD/CAM/CIM, 2nd Edition, New Age International (P) Ltd, New Delhi,2000. 4. Foley, Wan Dam, Feiner and Hughes – "Computer graphics principles and practice" Pearson Education -2003 5. Kunwoo Lee, Principles of CAD/CAM/CAE systems, Addison Wesley, 1999

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME532.1	Understand the principles and concepts underlying CAD/CAM systems.
R19ME532.2	Develop the two dimensional drafting and projection views
R19ME532.3	Analyze the CNC and Robot roles in the Manufacturing
R19ME532.4	Expand the various advanced manufacturing technquie and automation in industry.
R19ME532.5	Develop the Computer aided process plan with AI in manufacturing system

R19ME533	**Design Concepts in Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description					
Design Concepts in Engineering is an introductory course that delves into the core principles and methodologies of engineering design. Through a combination of lectures, hands-on exercises, and design projects, students will develop a comprehensive understanding of the design process from problem identification to solution implementation. The course					

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emphasizes critical thinking, creativity, and technical proficiency in addressing engineering challenges across various disciplines.
2. Course Objectives:
1. To study the various design requirements and get acquainted with the processes involved in product development.   2. To study the design processes to develop a successful product.   3. To learn scientific approaches to provide design solutions.   4. To study the principles of material selection, costing and manufacturing in design.
3. Syllabus
Unit-I: Design Terminology
Definition; various methods and forms of design, importance of product design; static and dynamic products; various design projects; morphology of design; requirements of a good design; concurrent engineering; computer aided engineering; codes and standards; product and process cycles; bench marking.
Unit-II: Introduction to Design Processes
Basic modules in design process; scientific method and design method; Need identification, importance of problem definition-structured problem, real life problem; information gathering, customer requirements; Quality Function Deployment (QFD);product design specifications, generation of alternative solutions; Analysis and selection; Detail design and drawings: Prototype, modeling, simulation, testing and evaluation.
Unit-III: Creativity in Design
Creativity and problem solving; vertical and lateral thinking; invention; psychological view, mental blocks; Creativity methods: brainstorming, synaptic, force fitting methods, mind map, concept map; Theory of innovative problem solving (TRIZ) ;conceptual decomposition creating design concepts
Unit-IV: Human and Societal Aspects in Product Development
Human factors in design, ergonomics, user friendly design; Aesthetics and visual aspects: environmental aspects, marketing aspects, team aspects, legal aspects and presentation aspects.
Unit-V: Material and Processes in Design
Material selection for performance characteristics of materials; selection for new design substitution for existing design; economics of materials: selection methods, recycling and material selection; types of manufacturing process, process systems; Design for Manufacturability (DFM);Design for Assembly (DFA).
Text Books:
1. Dieter. G. N., Linda C. Schmidt, "Engineering Design", McGraw Hill, 2013.   2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.
References Books:
1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.   2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, "Integrated Product and Process Design and Development", CRC Press, 2009.   3. James Garratt, "Design and Technology", Cambridge University Press, 1996.

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4. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, "Mechanical Engineering Design", McGraw Hill Professional, 2003. 5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME533.1	Analyze the various design requirements and get acquainted with the processes involved in product development..
R19ME533.2	Apply the design processes to develop a successful product.
R19ME533.3	Apply scientific approaches to provide design solutions.
R19ME531.4	Design solution through relate the human needs and provide a solution
R19ME533.5	Apply the principles of material selection, costing and manufacturing in design.

R19ME534	Non Traditional Machining Process	L	T	P	C
		3	0	0	3

1.Course Description:

This course provides a comprehensive overview of non-traditional machining processes, exploring advanced techniques used in manufacturing and engineering industries. Non-traditional machining processes are essential for producing intricate shapes, complex geometries, and exotic materials that cannot be efficiently or effectively machined using conventional methods. Throughout this course, students will delve into the theoretical principles, practical applications, and technological advancements of various non-traditional machining techniques.

2. Course Objectives:

1. To classify non-traditional machining processes and describe mechanical energy based nontraditional machining processes.
2. To differentiate chemical and electro chemical energy-based processes.
3. To describe thermo-electric energy-based processes
4. To explain Nano finishing processes.
5. To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

3.Syllabus

Unit-I: Introduction And Mechanical Energy Based Processes

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic

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machining their principles, equipment, effect of process parameters, applications, advantages and limitations.
Unit-II: Chemical And Electro Chemical Energy Based Processes
Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.
Unit-III: Thermo-Electric Energy Based Processes
Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.
Unit-IV: Nano Finishing Processes
Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.
Unit-V: Hybrid Non-Traditional Machining Processes
Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.
Text Books:
1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13:9788126910458 2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.
Reference Books:
1. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7. 2. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122. 3. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN13: 978-3319259208.

4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME534.1	Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.
R19ME534.2	Illustrate chemical and electro chemical energy based processes.
R19ME534.3	Evaluate thermo-electric energy based processes.
R19ME534.4	Interpret Nano finishing processes.
R19ME534.5	Analyse hybrid non-traditional machining processes and differentiate non- traditional machining processes.

R19ME535	**Rotating Machinery Design**	**L**	**T**	**P**	**C**
		3	0	0	3

1.Course Description:

This course provides an in-depth exploration of gas turbine design principles, focusing on operational regimes, design forces, failure criteria, blade design, and vibration mechanisms. Students will learn about the fundamental concepts of creep and fatigue damage, along with material and operational parameters affecting turbine performance. Practical aspects such as experimental procedures and design considerations are emphasized, preparing students for engineering challenges in gas turbine applications.

2. Course Objectives:

1. To understand the operational regimes of gas turbines, including base load, peak load, standby, and backup operations, and their respective requirements.
2. To identify the material, design, and operational parameters influencing creep and fatigue damage mechanisms in gas turbine applications.
3. To analyze the loads, forces, and stresses acting on gas turbine components, considering factors like rotational inertia, flight, and pressure gradients.
4. To evaluate failure criteria for gas turbine components, including monotonic failure criteria, theories of failure, and fatigue properties.
5. To apply principles of blade design and vibration analysis to optimize gas turbine performance and mitigate potential damage mechanisms, such as resonances and fatigue failures.

3.Syllabus

Unit-I: Introduction

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms; Material, design and operational parameters that affect creep and fatigue; Experimental and test procedures to characterize creep and fatigue damage.

Unit-II: Designing Forces

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Loads/forces/stresses in gas turbine engines: loads, rotational inertia, flight, precession of shafts, pressure gradient, torsion, seizure, blade release, engine mountings and bearings; Discussion of major loadings: rotating components and pressure casing components.
Unit-III: Failure Criteria
Monotonic failure criteria: proof, ultimate strength. Theories of failure: bi-axial loads, Other failure mechanisms: gas turbine engines including creep and fatigue; Fatigue properties; SN and RM diagrams; Stress concentration: mean stress, Cumulative fatigue, Goodman diagram and safety factor for gas turbine components. Larson-Miller time-temperature parameter.
Unit-IV: Blade Design
Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades: simple desk-top method; effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue.
Unit-V: Blade Vibrations And Damage Mechanisms
Natural frequencies turbomachine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances.
Text Books:
1. A S Rangawala, Turbomachinery Dynamics-Design and operations. McGraw-Hill, 2005, ISBN-13: 978-0071453691
2. Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN: 978-1119-63169-9
Reference Books:
1. P.P Walsh and P. Peletcher, Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843. 2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002. 3. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964. 4. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME535.1	Understand operational requirements and performance considerations in gas turbine applications.
R19ME535.2	Apply material science and design principles to mitigate creep and fatigue damage.
R19ME535.3	Analyze loads and stresses for robust turbine system design.

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R19ME535.4	Evaluate failure criteria and fatigue properties for structural integrity.
R19ME535.5	Design optimized gas turbine components for enhanced performance and reliability.

R19ME536	**Precision Manufacturing**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description

In high value added manufacturing industry, engineers are required to understand how mechanical systems and materials behave at length scales of microns and nanometres. This course develops the student's skills and knowledge in precision engineering, micro and Nano-engineering. The course will consider selected topics in precision, micro and Nano manufacturing, ranging from enabling technologies and processes to applications.

2. Course Objectives:

1. To familiarize the students in the science of precision engineering
2. To provide and enhance the technical knowledge in precision manufacturing and error control
3. To create the awareness among students about new trends in manufacturing and its precise control.
4. To Learn about the precision machine tools.

3. Syllabus

Unit-I: Introduction:

Basic definition: size scales, scaling analysis, technology change; Lithographic Processes: Optical and X-ray.

Unit-II: Precision Engineering and Practices

Definitions: sources of Error, basic concepts of machining, machine tool variables, accuracy, stiffness, spindle vibration, flatness, straightness, and smoothness of motion, 1-2 DOF systems; Variables: Feedback Variables; Cutting Tool Variables; Work piece Variables; Environment Effects and Thermal Errors.

Unit-III: Micromachining

Micromachining process: Laser Optics, Laser Ablation, Heat Affected Zone and Laser Polymerization. LIGA, S-LIGA Micro welding: Micro welding in similar and dissimilar materials; welding processes like ultrasonic, EB, LB; applications. Micro casting: Casting processes like vacuum, semi-solid state; applications Processing of Integrated Circuits, Clean rooms, crystal growing and shaping of wafers, Etching, Photo and other lithography techniques, Impurity introduction, Thermal oxidation, CVD, Metallization, IC packaging.

Unit-IV: Diamond Micromachining

Introduction: Diamond as a Tool Material, Compatible Materials, Diamond Performance; Diamond Machining: Micro-mechanical Applications, Diamond Machining as a Micro-mechanical Process Research Method, Ductile Regime Grinding.

Unit-V: Precision Machine Element

Introduction: Guide ways, Drive systems, Spindle drive, Preferred numbers; Rolling elements: hydrodynamic and hydrostatic bearings, Hybrid fluid bearings, Aero static and aero dynamic bearings, Hybrid gas bearings, Materials for bearings.

Text Books:

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017 2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017
References Books:
1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer 2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press 3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994. 4. Murthy.R.L, —Precision Engineering in Manufacturing, New Age International, New Delhi, 2005 5. Venkatesh V.C. and Izman S., —Precision Engineeringl, Tata McGraw Hill, 2007.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME536.1	Understand the meaning precision machining and the importance of it.
R19ME536.2	Understand the sources of errors and its effects
R19ME536.3	Apply the macro and micro components for fabrication of micro systems
R19ME536.4	Understand the diamond micromachining process and tools
R19ME536.5	Understand the principles of various precision engineering processes and apply them in actual field.

R19ME537	**Failure Analysis and NDT Techniques**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course provide detailed information on the different types of failure analysis, procedures used in industries for analysis alongside the materials failure. Besides it also gives and insight of different types of non-destructive techniques and their principles, inspection procedures and application in industries.

2.Course Objectives:

1. To introduce and familiarize the different Non-destructive testing techniques and its importance in manufacturing.
2. To understand basic working principle and its allied aspects for different widely used NDT techniques.
3. To enable the students for doing Failure analysis of a component and make them aware about different tools used.
4. To make student aware about the latest advancement in the codes and standards followed in NDT as well as advanced tools pertaining to Industry 4.0 in NDT

3.Syllabus

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Unit-I: Introduction and need and scope of failure analysis
Engineering Disasters and understanding failure analysis. Fundamental sources of failures. Deficient design. Improper Manufacturing & Assembly. Tree diagram and FMEA.
Unit-II: Fundamental sources of failures:
Poor assembly, service and maintenance, Industrial engineering tool for failure analysis: Pareto diagram Industrial engineering tool for failure analysis: Fishbone diagram and FMEA Industrial engineering tool for failure analysis: Reliability-I General procedure of failure analysis: Steps General procedure of failure analysis: Background information collection.
Unit-III: Overview of NDT
NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection, Unaided and aided.
Unit-IV: Surface Non Destructive Evaluation (NDE) Methods:
Liquid Penetrant Testing, Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods. Testing Procedure, Magnetic Particle Testing, Theory of magnetism, inspection materials. Magnetisation methods, Interpretation and evaluation, Principles and methods of demagnetization, Residual magnetism.
Unit-V: Acoustic Emission Testing:
Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. Thermograph: Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. In Situ Metallographic Examination: Approach to the Selection of Site for Metallographic examination, Replication process, Significance of Microstructure observation, Decision making, Applications, Codes and Standards.
Text Books:
1. General Dynamics Classroom Training Handbooks (Five Volumes), American Society for Non-Destructive Testing, Columbus, Ohio. 2. SHARPE, R.S., "Research Techniques in Non-Destructive Testing (Volumes I to VIII), American Society for Non-Destructive Testing, Columbus, Ohio
Reference Books: 1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014. 2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age InternationalPublishers, 2010.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME537.1	Determine the need and scope of failure analysis.
R19ME537.2	Analyze the fundamental sources of failures.
R19ME537.3	Understand the need and overview of NDT.
R19ME537.4	Apply the concepts of surface non-destructive evaluation (NDE) methods.
R19ME537.5	Understand the acoustic emission testing.

R19ME538	Tool Design	L	T	P	C
		3	0	0	3

1. Course Description:

This course covers the fundamentals of tool design, including classifications, materials, and standards. It delves into cutting tool design, jigs and fixtures, press tool dies, and tooling for CNC machines. Through theoretical and practical modules, students learn to design efficient tools for various manufacturing applications, from automotive to aerospace industries.

2. Course Objectives:

1. Grasp the classifications, materials, and standards essential for effective tool design, enabling them to analyse and select appropriate tools for manufacturing processes.
2. Develop skills in designing cutting tools, jigs, and fixtures tailored to specific machining requirements like CNC, ensuring precision and efficiency in manufacturing processes.

3. Syllabus

Unit-I: Introduction to Tool Design

Introduction to Tool Engineering: Tool Classifications, Tool Design Objectives, Tool Design in manufacturing, Challenges and requirements, Standards in tool design; Tool drawings: Surface finish, Fits and Tolerances; Tooling Materials: Ferrous and Nonferrous Tooling Materials, Carbides, Ceramics and Diamond; Nonmetallic tool materials; Designing with relation to heat treatment; ISO designation and applications; Tool holders for turning.

Unit-II: Design of Cutting tools

Mechanics of Metal cutting: Nomenclature and selection of cutting tool geometry, Single point cutting tools; Milling cutters; Hole making cutting tool; Broaching Tools; Design of Form relieved and profile relieved cutters; Design of gear and thread milling cutters.

Unit-III: Design of Jigs and Fixtures

Introduction to Fixed Gages: Gage Tolerances, selection of material for Gages; Indicating Gages; Automatic gages; Principles of location: Locating methods and devices; Principles of

clamping; Drill jigs: Chip formation in drilling, General considerations in the design of drill jigs, Drill bushings; Methods of construction: Thrust and Turning Moments in drilling; Drill jigs and modern manufacturing; Types of Fixtures: Vise Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures, Modular Fixtures; Cutting Force Calculations.
Unit-IV: Design of Press Tool Dies
Types of Dies; Method of Die operation: Design of drawing dies for simple components; Clearance and cutting force calculations; Blanking and Piercing die design: Pilots, Strippers and pressure pads; Presswork materials: Strip layout, Short-run tooling for Piercing, Bending dies, Forming dies, Drawing dies; Design and drafting of die tool.
Unit-V: Tool Design for CNC Machine Tools
Classification: Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes; Applications Case studies: Automotive, Aerospace and Electronics industries; Introduction to Tooling requirements for Numerical control systems; Fixture design for CNC machine tools: Sub plate and tombstone fixtures, Universal fixtures; Cutting tools; Tool holding methods: Automatic tool changers and tool positioners, Tool presetting; General explanation of the Brown and Sharp machine; Maintenance of CNC Machine tools.
Text Books:
1. Cyril Donaldson, George H. Lecain, V.C.Goold, "Tool Design", Mc Graw Hill Education, 5th edition,2017. 2. P.N.Rao, "Manufacturing technology", Mc Graw Hill Education, 4th edition, 2013.
Reference Books:
1. P.H.Joshi, "Jigs and Fixtures", Mc Graw Hill Education, 3rd edition, 2010. 2. Frank W.Wilson, "Fundamentals of Tool Design",PHI publications.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME538.1	Understand the standard and classification of cutting tool to machine a required job
R19ME538.2	Design a single point or multi point cutting tool for machining
R19ME538.3	Characterize the holding and clamping system for a given component.
R19ME538.4	Interpret and utilize engineering drawings, specifications, and industry standards relevant to tool design
R19ME538.5	Evaluate the functional requirements and constraints of a given manufacturing process to develop specialized tools that optimize production efficiency

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VERTICAL 4- DIGITAL AND GREEN MANUFACTURING

R19ME541	Digital Manufacturing and IOT	L	T	P	C
		3	0	0	3

1. Course Description

This course explores the integration of digital technologies with manufacturing processes, focusing on the Internet of Things (IoT) and its applications in modern manufacturing environments. Students will explore into the convergence of traditional manufacturing techniques with digital technologies, enabling enhanced efficiency, productivity, and flexibility in industrial operations.

2. Course Objectives:

1. To study the various concepts of digital manufacturing.
2. To inculcate the importance of digital manufacturing in Product Lifecycle Management and Supply chain Management.
3. To formulate of smart manufacturing systems in the digital work environment.
4. To interpret IoT to support the digital manufacturing.
5. To elaborate the significance of digital twin

3. Syllabus

Unit-I: Introduction:

Introduction; Need; Overview of Digital Manufacturing and the Past; Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management; Practical Benefits of Digital Manufacturing; The Future of Digital Manufacturing.

Unit-II: Digital life Cycle and Supply Chain Management

Collaborative Product Development: Mapping Requirements to specifications; Part Numbering; Engineering Vaulting; Product reuse; Engineering Change Management: Bill of Material and Process Consistency; Digital Mock up and Prototype development; Virtual testing and collateral; Overview of Digital Supply Chain: Scope& Challenges in Digital SC, Effective Digital Transformation, Future Practices in SCM.

Unit-III: Smart Factory

Smart Factory: Levels of Smart Factories, Benefits, Technologies used in Smart Factory; Smart Factory in IoT: Key Principles of a Smart Factory, Creating a Smart Factory, Smart Factories and Cybersecurity

Unit-IV: Industry 4.0

Introduction: Industry 4.0, Internet of Things, Industrial Internet of Things; Framework: Connectivity devices and services, Intelligent networks of manufacturing, Cloud computing, Data analytics, Cyber physical systems, Machine to Machine communication; Introduction to Arduino: Case Studies.

Unit-V: Digital Twin

Basic Concepts; Features and Implementation; Digital Twin: Digital Thread and Digital Shadow, Building Blocks, Types, Characteristics of a Good Digital Twin Platform, Benefits, Impact & Challenges, Future of Digital Twins.

Text Books:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.

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2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.

References Books:

1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME541.1	**(Understand)**Understand knowledge to use various elements in the digital manufacturing
R19ME541.2	**(Understand)**Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment
R19ME541.3	**(Apply)**Select the proper procedure of validating practical work through digital validation in Factories
R19ME541.4	**(Apply)**Apply the concepts of IoT and its role in digital manufacturing
R19ME541.5	**(Analyze)**Analyse and optimize various practical manufacturing process through digital twin

R19ME542	Robots and Systems in Smart Manufacturing	L	T	P	C
		3	0	0	3

1. Course Description

Robots and Systems in Smart Manufacturing explores the integration of robotics within modern manufacturing processes to optimize efficiency, productivity, and flexibility. This course delves into the principles, technologies, and applications of robotics in various manufacturing settings, emphasizing the transition towards Industry 4.0 and the Internet of Things (IoT).

2. Course Objectives:

1. To get a knowledge of working on Industrial robots and their load handling capacity
2. To enlist with an application of robots in various operation
3. To familiar with a material handling system
4. To impart the knowledge on robotic welding
5. To obtain the knowledge on various type of robot welding operation

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3. Syllabus
Unit-I: Introduction:
Types of industrial robots; Load handling capacity; general considerations in Robotic material handling; material transfer: machine loading and unloading, CNC machine tool loading, Robot centered cell
Unit-II: Selection of Robots and other Applications
Factors influencing the choice of a robot; robot performance testing; economics of robotisation: Impact of robot on industry and society; Application of Robots in continuous arc welding: Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.
Unit-III: Material Handling
Concepts of material handling; principles and considerations in material handling systems design; conventional material handling systems: industrial trucks, monorails, rail guided vehicles, conveyor systems, cranes and hoists; advanced material handling systems: automated guided vehicle systems, automated storage and retrieval systems(ASRS); bar code technology; radio frequency identification technology; Introduction to Automation Plant design software.
Unit-IV : Robotic welding
Robotic welding system; Programmable and flexible control facility; Introduction: Types, Flex Pendant, Lead through programming, Operating mode of robot, Jogging-Types, programming for robotic welding, Welding simulation, Welding sequences, Profile welding.
Unit-V: Applications of Robots in Welding and Allied Processes
Application of robot in manufacturing; Exploration of practical application of robots in welding: Robots for car body's welding, robots for box fabrication, robots for microelectronic welding and soldering; Applications in nuclear, aerospace and ship building; case studies for simple and complex applications
Text Books:
1. Richard D Klafter, Thomas Achmielewski, MickaelNegin , "Robotic Engineering – An integrated Approach", Prentice Hall India, New Delhi, 2006. 2. Mikell P Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, New York, 2019. 3. Pires J N, Loureiro A, Bolmsjo G, "Welding Robots: Technology, System Issues and Application", Springer, London, 2010.
References Books:
1. Parmar R S , "Welding Processes and Technology", Khanna Publishers, New Delhi, 2nd Edition, 2013. 2. John A. piotrowski, William T. Randolph , "Robotic welding: A Guide to Selection and Application, Welding Division, Robotics International of SME", Publications Development Dept., Marketing Division, 1987. 3. Mikell P Groover, Mitchel Weiss, Roger N Nagel, N.G.Odrey, AshishDutta , "Industrial Robotics (SIE): Technology, Programming and Applications", 2nd Edition, McGraw Hill Education India Pvt Ltd, 2012. 4. YoramKoren , "Robotics for Engineers", McGraw-Hill, 1987.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME542.1	(Understand) Recognize various concepts of Industrial Robot
R19ME542.2	(Apply) Select the appropriate Robots for assembly and underwater welding
R19ME542.3	(Apply) Select the appropriate material handling equipment's for smart manufacturing applications
R19ME542.4	(Understand) .Understand robotic welding system and Programming
R19ME542.5	(Apply) Select the appropriate Robots different applications

R19ME543	Industrial Robotics and Expert Systems	L	T	P	C
		3	0	0	3

1. Course Description:

The course "Industrial Robotics and Expert Systems" offers a comprehensive exploration of the integration of robotics technology and expert systems in industrial applications, providing students with a deep understanding of the principles, design considerations, and implementation strategies. The course emphasizes the seamless integration of robotics technology with expert systems to enhance automation, decision-making, and adaptability in industrial environments, enabling students to design and implement intelligent systems that optimize processes and drive innovation. With a focus on applications in manufacturing, assembly, logistics, quality control, and maintenance, students will analyse real-world examples and engage in hands-on robotics programming and simulation exercises using industry-standard software platforms. The students can also develop a holistic understanding of automation technologies and their responsible deployment in industrial settings.

2. **Course Objectives:**

1. To understand the fundamentals of robotics, including robot anatomy, coordinate systems and types/classifications, as well as terminology related to robot motion and specifications.
2. Explore various robot drive systems, end effectors, sensors, and machine vision techniques including their requirements, principles, applications and design considerations.
3. Develop proficiency in robot kinematics, programming, implementation, safety considerations, economic analysis and the integration of artificial intelligence & expert systems in industrial robotics applications.

3. Syllabus

Unit-I: Fundamentals of Robot

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Robot: Definition, Robot Anatomy, Co-ordinate Systems, Work Envelope, Types and Classification, Applications, Specifications; Terminologies: Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load; Robot Parts and their Functions; Need for Robots.
Unit-II: Robot Drive Systems and End Effectors
Drive Systems: Pneumatic, Hydraulic, Mechanical, Electrical (D.C. Servo Motors, Stepper Motors, A.C. Servo Motors) - Salient Features, Applications and Comparison of all these Drives; End Effectors; Grippers: Mechanical, Pneumatic, Hydraulic, Magnetic, Vacuum, Two Fingered & Three Fingered, Internal & External Grippers; Selection and Design Considerations of Grippers.
Unit-III: Sensors and Machine Vision
Sensor: Requirements, Principles and Applications; Types: Position sensors, Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors, binary Sensors, Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing &Digitizing Image Data: Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis; Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms; Applications: Inspection, Identification, Visual Serving, Navigation.
Unit-IV: Robot Kinematics and Robot Programming
Kinematics; Forward& Inverse Kinematics; Forward Kinematics and Reverse Kinematics of manipulators: With Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces; Manipulator Dynamics, Trajectory Generator; Manipulator Mechanism Design: Derivations, Problems; Robot Programming Languages: Lead through Programming, VAL Programming; Simple Programs: Motion, Sensor, End Effector commands.
Unit-V: Implementation, AI and Expert Systems
RGV; AGV; Implementation of Robots in Industries; Safety Considerations for Robot Operations; Economic Analysis of Robots; Artificial intelligence: Basics, Goals of artificial intelligence, AI techniques, Problem representation in AI, Problem reduction and solution techniques, Application of AI and KBES in Robots.
Text Books:
1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
2. John J. Craig, "Introduction to Robotics – Mechanics and control", 3rd edition, Prentice hall, 2005
3. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 2016.
References:
Reference Books:
1. Lynch, Kevin M., and Frank C. Park. Modern Robotics: Mechanics, Planning, and Control 1st ed. Cambridge University Press, 2017.

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2. S K Saha, Introduction to Robotics, Tata McGraw-Hill, Second Edition, 2017.
3. Arthor Critchlow, "Introduction to Robotics", 1st edition, Macmillan, 2009.
4. Deb S.R., "Robotics Technology and Flexible Automation", 2nd edition, Tata McGraw – Hill Publis Robotics: Control and Programming.
5. Tsuneo Yohikwa. Foundations of Robotics Analysis and Control. Prentice Hall of India Pvt. Ltd., 2001
MOOC/SWAYAM/NPTEL Courses:
1. https://onlinecourses.nptel.ac.in/noc23_me143/preview
2. https://nptel.ac.in/courses/112107289
3. https://archive.nptel.ac.in/courses/112/105/112105249/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME543.1	Explain the concepts of industrial robots, classification, specifications and coordinate systems
R19ME543.2	Illustrate the different types of robot drive systems as well as robot end effectors.
R19ME543.3	Apply the different sensors and image processing techniques in robotics to improve the ability of robots
R19ME543.4	Develop robotic programs for different tasks and familiarize with the kinematics motions of robot
R19ME543.5	Examine the implementation of robots in various industrial sectors and understand the application of AI and KBES in Robots.

R19ME544	Green Manufacturing Design And Practices	L	T	P	C
		3	0	0	3

1. Course Description:

This course introduces students to the principles and practices of green manufacturing, focusing on environmentally friendly approaches to designing and implementing manufacturing processes. Topics include resource efficiency, waste reduction, energy conservation, and pollution prevention. Students will learn about sustainable materials, renewable energy integration, and regulatory compliance. Through case studies and hands-on activities, students will gain the skills needed to promote sustainability in manufacturing operations.

2. Course Objectives:

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1. To introduce the concept of environmental design and industrial ecology.
2. To impart knowledge about air pollution and its effects on the environment.
3. To enlighten the students with knowledge about noise and its effects on the environment.
4. To enlighten the students with knowledge about water pollution and its effects on the environment.
5. To introduce the concept of green co-rating and its need

3. Syllabus

Unit-I: Design for Environment and Life Cycle Assessment

Environmental effects of design; selection of natural friendly material; Eco design; Environmental damage, Material flow and cycles; Material recycling; Emission less manufacturing; Industrial Ecology; Pollution prevention; Reduction of toxic emission; design for recycle.

Unit-II: Air Pollution Sampling and Measurement

Pollutants: Primary and Secondary Pollutants, Automobile Pollutants; Industrial Pollution; Ambient air quality Standards; Metrological aspects of air Pollution; Temperature lapse Rates and Stability-wind velocity and Turbulence; Pump behaviour dispersion of air Pollutants; solution to the atmosphere dispersion equation; the Gaussian Plume Model; Air pollution sampling; collection of gaseous air pollutants collection of particulate pollutants; stock sampling; analysis of air pollutants: sulphur-dioxide, nitrogen-dioxide, carbon monoxide, oxidants and ozone.

Unit-III: Noise Pollution and Control

Frequency and Sound Levels; Units of Noise based power radio; contours of Loudness; Effect of human; Environment and properties; Natural and Androgenic Noise Sources; Measuring Instruments for frequency and Noise levels; Masking of sound: Types, Kinetics, Selection of different reactors used of or waste treatment; Treatment of noise at source; Path and Reception; Sources of noise; Effects of noise; Occupational Health hazards.

Unit-IV: Water Demand and Water Quality

Factors affecting consumption; Variation; Contaminants in water; Nitrates; Fluorides; Detergents; taste and odour; Radio activity in water; Criteria; for different impurities in water for portable and non-portable use; Point and non-point Source of pollution; Major pollutants of Water; Water Quality Requirement for different uses; Global water crisis issues.

Unit-V: Green Co-Rating

Ecological Footprint; Need for Green Co-Rating; Green Co-Rating System; Intent: System Approach, Weightage, Assessment Process; Types of Rating; Green Co-Benefits; Case Studies of Green Co-Rating.

Total: 45 Hours

Text Books:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd.,New Delhi, Second Edition, 2006

References Books:
1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010 2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993. 3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005. 4. Rao M.N. and Dutta A.K. "Wastewater treatment", Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006 5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006. 6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME544.1	**(Understand)** Explain the environmental design and selection of eco-friendly materials.
R19ME544.2	**(Understand)** Analyse manufacturing processes towards minimization or prevention of air pollution.
R19ME544.3	**(Analyse)** Analyse manufacturing processes towards minimization or prevention of noise pollution.
R19ME544.4	**(Analyze)** Analyse manufacturing processes towards minimization or prevention of water pollution.
R19ME544.5	**(Evaluate)** Evaluate green co-rating and its benefits.

R19ME545	Environment Sustainability And Impact Assessment	L	T	P	C
		3	0	0	3
1.Course Description:					
Environment Sustainability And Impact Assessment (ESIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse ESIA is basically a tool used to assess the positive and negative environmental, economic and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts.					

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In this course students will develop basic understanding of the history, need, structure, process, involved methods and challenges. Students will also learn criteria for selecting method for impact assessment, overview of methods, parameters for public participation ad technique for writing reports.
2. Course Objectives:
1. Identifying, predicting, and evaluating economic, environmental, and social impacts of development activities. 2. Providing information on the environmental consequences for decision making. 3. Promoting environmentally sound and suitable development by identifying appropriate alternatives and mitigation measures.
3.Syllabus
Unit-I: Energy And Climate Change
Global Consensus; GHGs emission and energy activities; Montreal protocol, evidence and predictions and impacts, Clean energy technologies, Energy economy, Risk and opportunities; Measures to reduce GHGs; Role of renewable energy, Evidence of economic impacts of climate change and economics of stabilizing greenhouse gases.
Unit-II: Environment and Society
Energy; environment and society Nature, scope and analysis of local and global impacts of energy use on the environment; fossil fuel burning and related issues of air pollution; greenhouse effect; global warming and, urban heat island effect; nuclear energy and related issues such as radioactive waste; spent fuel; social inequalities related to energy production; distribution, and use.
Unit-III: Green Technologies
Concept Definition and concepts: green technology, green energy, green economy, and green chemistry; sustainable consumption of resources; individual and community level participation, energy conservation; encouraged use of public transport instead of private transport. Successful green technologies: wind turbines, solar panels; 3 R's of green technology: recycle, renew and reduce; paradigm shift from 'cradle to grave' approach. Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies.
Unit-IV: Environmental Mitigation & Sustainability
Environmental effects of energy extraction, conversion and use, Sources of pollution: Air, water, soil, thermal, noise pollution- cause and effect; Causes of global, regional and local climate change; Pollution control methods; Environmental laws on pollution control: Global warming: Green House Gas emissions, impacts, mitigation; Sustainability, Externalities, Future energy systems, Clean energy technologies, United Nations Framework Convention on Climate Change (UNFCC), Sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), Prototype Carbon Fund (PCF)
Unit-V: Environmental Impact Assessment
Environmental Impact Analysis; Environmental Impact Assessment and Environmental Impact Statement; EIA- As an Integral part of The planning Process, Detailed Contents of EIA: Introduction; Project Description; Description of The Environment; Anticipated Environmental Impacts And Mitigation Measures: Analysis of Alternatives; Environmental

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Monitoring Programme; Additional studies; Project Benefits; Environmental Cost Benefit Analysis
Text Books:
1. Saxena A. B. (2011); A Textbook of Energy, Environment, Ecology and Society, New Age International 2. Kaushika N. D. and Kaushik K. (2004); Energy, Ecology and Environment: A Technological Approach, Capital Publishing
Reference Books: 1. Environmental Impact Analysis Handbook – by Rau Whooten; McGraw Hill publications 2. Environmental Impact Assessment – by Larry Canter; McGraw Hill publications 3. Environmental Impact Analysis – A Decision Making Tool by R K Jain 4. Handbook of Environment Impact Assessment by Judith Petts; McGraw Hill publications

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME545.1	**(Analyse)** To Analyse the causes and effects of 'environmental degradation' and resource depletion & development.
R19ME545.2	**(Understand)** To give an understanding on energy extraction, conversion, uses and their impact on natural habitat.
R19ME545.3	**(Understand)** To generate understanding on energy and environment related issues.
R19ME545.4	**(Understand)** To create an understanding on the linkages between economic growth and energy consumption.
R19ME545.5	**(Apply)** Acquire scientific and engineering knowledge on the renewable energy aspects and associated current environment issues.

R19ME546	**Lean Manufacturing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1.Course Description:					
Lean Manufacturing has revolutionized the way industries operate by optimizing processes, eliminating waste, and enhancing efficiency. This course provides a comprehensive exploration of Lean Manufacturing principles and practices, equipping students with the					

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knowledge and skills necessary to implement lean methodologies in various manufacturing settings.

2. Course Objectives:

1. To introduce the basics of 6 SIGMA
2. To learning about the lean manufacturing tools.
3. To study about the deeper understanding methodologies of Lean manufacturing.
4. To study the lean concepts and its elements.
5. To learn implementation and challenges of lean manufacturing.

3. Syllabus

Unit-I: Basics Of 6 Sigma

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

Unit-II: Introduction To Lean Manufacturing Tools

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

Unit-III: Deeper Understanding Methodologies

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, and Introduction to Toyota Production System, Six Sigma and Production System integration.

Unit-IV: Lean Elements

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

Unit-V: Implementation And Challenges

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc

Text Books:

1. Dennis P.," Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007.
2. Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004.

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Reference Books:
1. NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123 : Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning). 2. Charron, R., Harrington, H. J., Voehl, F., & Wiggin, H. (2014). The lean management systems handbook (Vol.4). CRC Press.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME546.1	Discuss the basics of 6 SIGMA
R19ME546.2	Elaborate the lean manufacturing tools.
R19ME546.3	Illustrate about the deeper understanding methodologies of Lean manufacturing.
R19ME546.4	Discuss lean concepts and its elements.
R19ME546.5	Describe the implementation and challenges of lean manufacturing

R19ME547	Green Supply chain Management	L	T	P	C
		3	0	0	3

1. Course Description:

This course explores the principles, practices, and strategies involved in creating sustainable and environmentally friendly supply chains. It examines how organizations can integrate environmental considerations into various aspects of supply chain management to reduce their ecological footprint, minimize waste, and promote social responsibility.

2. Course Objectives:

1. To familiar the various standards and legislation of modern electronic manufacturing.
2. To know the conventional electronic processing and lead-free electronic manufacturing techniques.
3. To recognize the steps involved in assembly process and understand the need of recycle the electronics
4. To implement reliability and product life cycle estimation tools in green electronic manufacturing.
5. To demonstrate the green electronic manufacturing procedure in applications.

3. Syllabus

Unit-I: Introduction to Green Electronics

Environmental concerns of the modern society; Overview of electronics industry and their relevant regulations in China, European Union and other key countries: global and regional strategy and policy on green electronics industry; Restriction of Hazardous substances (RoHS); Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration; Evaluation; Authorization and Restriction of Chemical substances (REACH).

Unit-II: Green Electronics Materials and Products

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Basics of IC manufacturing and its process: Electronics with Lead (Pb), free solder pastes, conductive adhesives; Introduction to green electronic materials and products: halogen-free substrates and components; Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products.
Unit-III: Green Electronics Assembly and Recycling
Various processes in assembling electronics components; the life-cycle environmental impacts of the materials used in the processes; substrate interconnects; Components and process equipments; Technology and management on e-waste recycle system construction; global collaboration and product disassembles technology.
Unit-IV: Product Design and Sustainable Eco-Design
Stages of product development process in green design: Materials, Manufacturing, Packaging and use, End of Life and disposal; Design for recycling; Life Cycle Assessment (LCA), and Eco-design tools, Environmental management systems, and International standards; Eco-design in electronics industry.
Unit-V: Case Studies
Reliability of green electronics systems; Reuse and recycle of End-of-Life(EOL); electrical and electronic equipment for effective waste management; Introduction of Green Supply Chain;Modeling green products from Supply Chain point of view; A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.
Text Books:
1. Green Supply Chain Management, by CharisiosAchillas ,Dionysis D. Bochtis , Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617 2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.
References Books:
1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006. 2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011. 3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014. 4. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006. 5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010. 6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

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4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME547.1	**(Understand)** Know the awareness of standards and legislation of modern electronic manufacturing for green environment..
R19ME547.2	**(Understand)**Explain the conventional electronic processing and lead free electronic manufacturing techniques.
R19ME547.3	**(Analyze)**Analyze the impacts of materials used in electronic products
R19ME547.4	**(Apply)**Use reliability and product life cycle estimation tools for electronic manufacturing
R19ME547.5	**(Apply)** Use the green electronic manufacturing procedures in applications.

R19ME548	**Computer Aided Inspection and Testing**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

This course introduces Computer-Aided Quality Control (CAQC) techniques, including Computer-Aided Testing (CAT) and Inspection (CAI). Students explore Coordinate Measuring Machines (CMMs), machine vision systems, laser measurement technologies, proximity sensing, and flow measurement techniques. Through theoretical and practical modules, students gain expertise in modern quality control methodologies essential for precision manufacturing processes.

2. Course Objectives:

1. Learn CAT, CAI, and online inspection techniques for precision manufacturing.
2. Gain expertise in CMMs, machine vision, and laser measurement technologies for quality control.

3. Syllabus

Unit-I: Introduction to CAQC

Computer aided testing (CAT) and computer aided inspection (CAI); Computer aided quality control (CAQC): On-line inspection and quality control, Technology of automation Gauging, Automatic inspection machines, In-process gauging; Introduction to Dimensional and Geometric Tolerance: interchangeability.

Unit-II: Coordinate Measuring Machine

Co-Ordinate Measuring Machines: Basic Types of Measuring Machines, probe types, operating modes, programming software's, accessories, measurement and inspection capabilities, flexible inspection systems, inspection problems.

Unit-III: Machine Vision and Scanning Devices

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Functions of machine vision system; Evaluating the performance of machine vision system; Machine vision applications; LASER light source: LASER interferometer, LASER alignment telescope, LASER micrometer, Online and in-process measurements of diameter, Roundness and surface roughness using LASER; Micro holes and topography measurements; Straightness and flatness measurement system.
Unit-IV: Machine Tool and Proximity Sensing
Machine Tool Sensing: Part measurement, Tool wears, Axial, motion, Sequence of functions, tool identification; Computer aided surface roughness measuring systems: High accuracy profile measuring systems; Proximity Sensing: Photoelectric Transducers, Image processing for vision sensor, 3 dimensional object recognition.
Unit-V: Flow Measurement
Flow Measurement: Flow visualization, shadowgraph; schlieren and interferometric techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velometer; Flow measurements using coriolis effect.
Text Books:
1. Bewoor A.K., and Kulkarni,V.A., Metrology and Measurement, Tata McGraw-Hill., India, 2009. 2. Jain R.K., Engineering Metrology, Khanna Publishers., India, 2009.
Reference Books:
1. Gupta S.C, Engineering Metrology, Dhanpat rai Publications, 2005 2. Jayal A.K, Instrumentation and Mechanical Measurements, Galgotia Publications 2000

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME548.1	Understand the principles and importance of inspection and testing in engineering and manufacturing processes
R19ME548.2	Apply computer-aided inspection methods to identify defects, errors, and anomalies in engineering components and products.
R19ME548.3	Apply quality assurance and control principles with the help of computer-aided inspection techniques.
R19ME548.4	Demonstrate competency in data visualization and reporting using computer tools for inspection and testing purposes.
R19ME548.5	Recognize emerging technologies and potential challenges in the field of computer-aided inspection and testing.

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VERTICAL 5 - PRODUCT AND PROCESS DEVELOPMENT

R19ME551	Product Design and Development	L	T	P	C
		3	0	0	3

1. Course Description:

The course aim is to provide student with the concepts and tools for the design of new products. The different approaches and methodologies for the design of new products, the stages of the design project, the design and the quality with fundamental practices of design are reviewed. Economic, financial and operational evaluations. Criteria for the selection of new products. Product life cycle. Also the mechanisms and approaches for the introduction of new products.

2.Course Objectives:

1 Understand modern product development processes.
2 Understand and explain the concept of Industrial design and robust design concepts.
3 Understand the concept of Design for manufacture and assembly.
4 Understand the legal factors, social issues, engineering ethics related to product design

3.Syllabus

Unit-I: Introduction on Design and development of products

Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

Unit-II: Product Planning:

The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

Unit-III: Product Specifications:

What are specifications, when are specifications established, establishing target specifications, setting the final specifications. 5. Concept Generation: The activity of concept generation, clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. Concept Selection, Overview of methodology, concept screening, and concept scoring.

Unit-IV: Concept Testing

Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. **Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process and assessing the quality of industrial design

Unit-V: Design for Manufacturing:

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Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Prototyping, Prototyping basics, principles of prototyping, technologies, planning for prototypes.
Text Books:
1. Product Design and Development - Karl.T.Ulrich, Steven D Eppinger - Irwin McGrawHill - 2000 2. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition, 2003.
Reference Books:
1. New Product Development - Timjones. Butterworth Heinmann - Oxford. UCI -1997 2. Product Design for Manufacture and Assembly – Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME551.1	Understand the product design and development process
R19ME551.2	Apply creative thinking skills for idea generation.
R19ME551.3	Translate conceptual ideas into products.
R19ME551.4	Present ideas using various types of model.
R19ME551.5	Design for manufacturing the product.

R19ME552	Robotic Process Automation	L	T	P	C
		3	0	0	3

1. Course Description:
The Robotic Process Automation (RPA) Fundamentals course offers a comprehensive introduction to the principles, techniques, and applications of RPA technology. RPA is revolutionizing industries by automating repetitive and rule-based tasks traditionally performed by humans, thus enhancing operational efficiency and reducing costs. This course provides students with a solid foundation in RPA concepts, tools, and best practices, empowering them to leverage automation for process optimization and innovation.
2. Course Objectives:
1. To understand the RPA and the ability to differentiate it from other types of automation. 2. To model the sequences and the nesting of activities. 3. To understand Image, Text and Data Tables Automation. 4. To interpret the events that can be used to trigger actions.

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5. To demonstrate the facility for scheduling bots and specifying the time intervals
3. Syllabus
Unit-I: Introduction to Robotic Process Automation
Automation; RPA vs Automation: Processes & Flowcharts; Programming Constructs in RPA; What Processes can be Automated: Types of Bots; Workloads which can be automated; RPA Advanced Concepts; Standardization of processes; RPA Development methodologies; Difference from SDLC; Robotic control flow architecture; RPA business case; RPA Team; Process Design Document/Solution Design Document; Industries best suited for RPA; Risks & Challenges with RPA; RPA and emerging ecosystem.
Unit-II: RPA Tool Introduction and Basics
Introduction to RPA Tool: The User Interface, Variables: Managing Variables, Naming Best Practices, The Variables Panel, Types of Variables; Arguments: Managing Arguments, Naming Best Practices, The Arguments Panel, Using Arguments; About Imported Namespaces: Importing New Namespaces; Control Flow: Control Flow Introduction, If Else Statements, Loops, Advanced Control Flow, Sequences, Flowcharts; Data Manipulation: Data Manipulation Introduction, Scalar variables, collections and Tables, Text Manipulation, Data Manipulation, Gathering and Assembling Data
Unit-III: Advanced Automation Concepts and Techniques
Recording Introduction; Basic and Desktop Recording, Web Recording, Input/Output Methods, Screen Scraping ,Data Scraping, Scraping advanced techniques; Selectors: Defining and Assessing Selectors, Customization, Debugging, Dynamic Selectors, Partial Selectors; RPA Challenge; Image, Text & Advanced Citrix Automation; Introduction to Image & Text Automation; Image based automation; Keyboard based automation; Information Retrieval; Advanced Citrix Automation challenges.
Unit-IV: Handling User Events and Assistant Bots, Exception Handling
Assistant bots; Monitoring system event triggers; Hotkey trigger; Mouse trigger; System trigger; Monitoring image and element triggers; An example of monitoring email; Example of monitoring a copying event and blocking it; Launching an assistant bot on a keyboard event. Exception Handling: Debugging and Exception Handling; Debugging Tools; Strategies for solving issues; Catching errors.
Unit-V: Deploying and Maintaining The Bot
Publishing using publish utility; Creation of Server; Using Server to control the bots; Creating a provision Robot from the Server; Connecting a Robot to Server; Deploy the Robot to Server; Publishing and managing updates; Managing packages; Uploading packages; Deleting packages
Text Books:
1. Alok Mani Tripathi, "Learning Robotic Process Automation",Packt Publishing, 2018.
References Books:

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1. Frank Casale, Rebecca Dilla, Heidi Jaynes , Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant", Independently Published, 1st Edition 2018.
3. Srikanth Merianda,"Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018.
4. Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes",Packt Publishing, 1st Edition 2018.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME552.1	**(Understand)** Describe RPA from other automation methods and comprehend its core principles.
R19ME552.2	**(Understand)** Describe the different types of variables, Control Flow and data manipulation techniques.
R19ME552.3	**(Apply)** Apply the automation techniques for images, text, and data tables in RPA applications.
R19ME552.4	**(Analyze)** Interpret trigger events for initiating actions within RPA processes
R19ME552.5	**(Apply)** Demonstrate competence in scheduling bots and specifying time intervals for efficient automation workflows.

R19ME553	**Additive Manufacturing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description

The additive manufacturing courses provides necessary knowledge and skills to excel in the field of 3D printing and additive manufacturing. These courses are designed to prepare for a career in areas such as product design, manufacturing engineering, prototyping, and materials science, equipping you with the latest techniques and expertise in this rapidly advancing field. This course dives into the different processes used in additive manufacturing, such as Fused Deposition Modeling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), and more. It covers the working principles, advantages, and limitations of each process.

2. Course Objectives:

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1. To learn about the rapid prototyping and its applications 2. To learn about the solid and liquid based manufacturing systems 3. To understand the working principle of electron beam and laser sintering process 4. To understand the fundamentals of reverse engineering and nature of materials
3. Syllabus
Unit-I: Introduction:
Overview: Need, Development of AM, Generalized AM process chain; Rapid prototyping: Rapid tooling, Rapid manufacturing, Materials for AM technology, Metal and Polymer additives; Introduction about machines used in additive manufacturing; Applications of AM; Benefits; Case studies.
Unit-II: Liquid and Solid Based Additive Manufacturing Systems
Classification: Liquid based system, Stereolithography, Direct light processing; Jetting systems: Principle, process, products, advantages, limitations and applications; Solid based system: Fused deposition modeling; Laminated object manufacturing: Principle, process, products, advantages, limitations and applications.
Unit-III: Powder Based Additive Manufacturing Systems
Powder based system: Selective laser sintering, Three dimensional printing, Direct metal deposition, Ballistic particle manufacturing; Electron beam melting and Laser engineered net shaping: Working Principle, Construction, Process Variables, Materials, advantages, limitations and Applications.
Unit-IV: CAD and Reverse Engineering
CAD Modelling for 3D printing: 3D Scanning and digitization, data handling and reduction methods. AM Software: data formats and standardization. Slicing algorithms: uniform flat layer slicing, adaptive slicing, Process-path generation: Process-path algorithms, rasterization, part Orientation and support generation.
Unit-V: Materials and Applications of Am Systems
Nature of material: types of material for AM, Liquid based materials, photo polymer development, solid based materials: powder based materials. Metal vs Polymer AM: Application of additive manufacturing in medical, manufacturing, automotive, aerospace and electronics industries, Case studies.
Text Books:
1. Andreas Gebhardt "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing" Hanser Gardner Publication 2016. 2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third edition, World Scientific Publishers, 2015.
References Books:
1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications :A tool box for prototype development", CRC Press, 2017 2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2016 3. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2013 4. Ian Gibson, David W.Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer, 2015

5.	Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2000

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME553.1	Explain basic concepts and classify the various additive manufacturing processes
R19ME553.2	Select suitable liquid and solid based processes based on the application
R19ME553.3	Apply powder based rapid prototyping systems in suitable applications
R19ME553.4	Implement reverse engineering techniques for developing prototypes
R19ME553.5	Develop knowledge on materials and novel applications additive manufacturing technologies

R19ME554	**Total Quality Management**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

The current course addresses the subjects of Continuous quality improvement, total quality control, cost of quality, competitive advantage, problem solving, and Statistical Process Control (SPC). Additional, the requirements of adopting and applying TQM Thought. This course also boost the required skill, understanding and confidence to partake in and play a significant role in the implementation of a total quality management system in the organization, in turn supporting career growth and progression. Additionally, the required skillset and capabilities to work with advanced tools and concepts to set up total quality management systems within the organization.

2.Course Objectives:

1. To understand the basic concepts and theories of Total quality Management.
2. Apply the concepts of total quality management.
3. To appreciate the importance of cost of quality
4. To develop basic understanding of requirements of TQM.
5. To be aware of the statistical process control with IS0 and its concept in Quality Management.

3.Syllabus

Unit-I: Quality Concepts:

Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design. Control on Purchased Product: Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

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Manufacturing Quality: Methods and Techniques for manufacture, Inspection and control of product, Quality in sales And services, Guarantee, analysis of claims
Unit-II: Quality Management:
Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme. TQM Principles: Leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCE cycle, 5S,Kaizen; Supplier partnership, Partnering, Supplier rating & selection.
Unit-III: Tools and Techniques
Seven QC tools (Histogram, Check sheet, Ishikawa diagram, Pareto, Scatter diagram, Control chart, flow chart). Control Charts: Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts, P-charts and C-charts..
Unit-IV: Defects Diagnosis and Prevention
Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.
Unit-V: ISO and its concept of Quality Management
Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, QS 9000, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors, Auditing, Taguchi method, JIT in some details.
Text Books:
1. Total Quality Management, by Dale H. Besterfield, Pearson India. 2. Beyond Total Quality Management, Greg Bounds, McGraw Hill.
Reference Books: 1. H Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., firstIndian edition, Cengage Learning, 2012. 2. Total Quality Management by Mukherjee, P.N. TQM in New Product manufacturing, H. G. Menon, McGraw Hill 3 Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME554.1	Learn the basic concepts of quality and quality from organizational point of view.
R19ME554.2	Apply the concepts of total quality management.
R19ME554.3	Learn the Quality Tools and Techniques of organization.
R19ME554.4	Understand the Defects Diagnosis and Prevention in Quality.
R19ME554.5	Understanding on IS0 and its concept in Quality Management.

R19ME555	Design for Manufacturing And Assembly	L	T	P	C
		3	0	0	3

1.Course Description:

Design for Manufacturing and Assembly (DFMA) is a set of overlapping principles applied to engineering design that consider requirements beyond the functional. DFA ensures a good design early in the design process by focusing on the number of parts, part handling, and ease of assembly.

2. Course Objectives:

1. To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2. To learn the design consideration principles of machining and metal casting process.
3. To learn design consideration principles of welding in the design of welded products.
4. To learn the automation process during the assembly
5. To learn design consideration principles in additive manufacturing

3.Syllabus

Unit-I: Introduction

Design philosophy steps in Design process - General Design rules for manufacturability, basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection – Material selection interrelationship with process selection process selection charts.

Unit-II: Machining Process & Metal Casting

Machining Process: Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design

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recommendations for machined parts. Metal Casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.
Unit-III: Welding processes
Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, and Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking. Viscoelastic and Creep behaviour in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding.
Unit-IV: Automation for Assembly
Assemble Advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Automatic Assembly Transfer Systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.
Unit-V: Design of Manual Assembly
Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and R19 M.TECH DFM/D&M 5 fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.
Text Books:
1. D.E. Whitney,(2004) Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development, Oxford University Press, New York 2. Geoffrey Boothroyd (2005) Assembly Automation and Product Design, Second Edition, CRC press, Taylor & Francis, Florida, USA
Reference Books:
1. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/CRC Press/2010 2. Boothroyd G., Dewhurst P. and Knight W. – 'Product Design for Manufacture and Assembly' – Marcel Dekker, New York – 2012 – 4th Edition

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME555.1	Understand the quality aspects of design for manufacture and assembly
R19ME555.2	Apply Boothroyd method of DFM for product design and assembly
R19ME555.3	Apply the concept of DFM for casting, welding, forming and assembly
R19ME555.4	Identify the design factors and processes as per customer specifications
R19ME555.5	Apply the DFM method for a given product

R19ME556	**Advanced Manufacturing Systems**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description

Advanced Manufacturing Systems is an advanced-level course that examines the principles, methodologies, and technologies shaping modern manufacturing practices. Through a blend of theoretical discussions, case studies, and hands-on exercises, students will gain a comprehensive understanding of advanced manufacturing concepts and their applications in industry. The course emphasizes the integration of automation, robotics, digital technologies, and process optimization to enhance productivity, flexibility, and sustainability in manufacturing operations.

2. Course Objectives:

1. To Analyze and determine material fabrication processes.
2. To use laboratory instrument doing routine metrological measurements
3. To recognize engine machine tool requirements and be selective in the choice of tools.
4. To setup and operate machines, index and determine machine speeds, feeds, and depth of cut requirements.

3. Syllabus

Unit-I: Surface Treated in Manufacturing

Surface treatment: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding..

Unit-II: Non-Traditional Machining

Introduction, need, AJM, Parametric Analysis, Process capabilities, USM; Mechanics of cutting, models, Parametric Analysis, WJM: principle, Equipment, process characteristics, performance, EDM: principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish and WEDM.

Unit-III: Advanced Machining Process

Laser Beam Machining: Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications; Plasma Arc Machining; Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications; Electron Beam Machining; Principle of working, equipment,

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Material removal rate, Process parameters, performance characterization, Applications; Electro Chemical Machining: Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
Unit-IV: Processing of Ceramics
Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying , sintering, Hot compaction, Area of application , finishing of ceramics Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.
Unit-V: Fabrication of Microelectronic Devices
Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology, and micromachining, High speed Machining.
Text Books:
1. Manufacturing Engineering and Technology, Kalpakijian, Adisson Wesley, 2016. 2. Advanced Machining Processes, 2015,V.K.Jain, Allied Publications.
References Books:
1. Introduction to Manufacturing Processes, John A Schey, Mc Graw Hill.2017 2. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover,2013. 5th Edition, Wiley Publication 3. Non-traditional Micromachining Processes Fundamentals and Applications edited by Golam Kibria, B. Bhattacharyya and J. Paulo Davim, Springer.2016. 4. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006. 5. Rao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi, 2009

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME556.1	Knowledge of the principles and concepts of advanced manufacturing processes
R19ME556.2	Evaluate the capabilities and limitations of additive manufacturing techniques.
R19ME556.3	Design and implement advanced manufacturing systems.
R19ME556.4	Manage and expand the advanced manufacturing systems in ceramics processing.
R19ME556.5	Interpreting the knowledge on of the microelectronic devices

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R19ME557	Product Life Cycle Management	L	T	P	C
		3	0	0	3

1.Course Description:

Product Life Cycle Management is a comprehensive course designed to provide students with an in-depth understanding of the stages, strategies, and methodologies involved in managing a product throughout its life cycle, from inception to retirement. This course explores various concepts, tools, and techniques essential for effectively managing products in diverse industries and markets.

2. Course Objectives:

1. To recognizing the value of the product life cycle (PLC) in marketing and product management initiatives.
2. To exploring the preliminary stages of product development, such as idea generation, concept development, market research, prototyping, and testing the market.
3. To assessing various product introduction tactics, including as distribution, price, timing, positioning, and marketing initiatives.
4. To evaluating how divisions like marketing, product development, operations, finance, and sales may work together across functional boundaries to manage product life cycles efficiently.

3.Syllabus

Unit-I: Introduction To PLM & PDM

Product Lifecycle Management: Introduction to PLM, Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation; Product Data Management: Implementation of PDM systems.

Unit-II: Product Design

Product Design: Engineering design, Decomposition in product design, Product design process, Methodical evolution in product design, Concurrent engineering, Design for 'X' & design central development model; Strategies of PLM: Strategies for recovery at end of life, recycling, human factors in product design, Modelling and simulation in product;

Unit-III: Product Development

New Product Development: Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product;

Unit-IV: Technology Forecasting

Technology Forecasting: Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram, Combining forecast of technologies, Integration of technological product innovation, product development in business processes within enterprises, methods &tools in the innovation process according to the situation, Methods & tools in the innovation process according to the situation;

Unit-V: Product Building And Structures

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Virtual product development: Tools for components, Machines; Manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, Product data technology; Product structures: Variant management, product configuration, Material master data, Product description data, Data models, Life cycles of individual items, status of items;
Text Books:
1. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105 2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006
Reference Books:
1. Saaksvuori Antti / ImmonenAnselmie, product Life Cycle Management Springer, Dreamtech, 3-540-25731-4 2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME557.1	**(Understand)** Explain the various strategies of PLM and Product Data Management.
R19ME557.2	**(Understand)** Describe decomposition of product design and model simulation
R19ME557.3	**(Apply)** Apply the concept of New Product Development and its structuring
R19ME557.4	**(Analyze)** Analyze the technological forecasting and the tools in the innovation.
R19ME557.5	**(Apply)** Apply the virtual product development and model analysis

R19ME558	**Process Planning and Cost Estimation**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**
1.Course Description:					
This course provides a comprehensive exploration of to understand the basic concepts of process Planning and estimation and apply different methods of cost estimation in different manufacturing shops and learn the concepts of process planning and cost estimation in competitive manufacturing systems and organizations.					
2. Course Objectives:					

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1. To introduce the process planning concepts to make cost estimation for various products after process planning.
2. The chief of process planning is to augment and modernize the business methods of a company. Process planning is planned to renovate design specification into manufacturing instructions and to make products within the function and quality specification at the least possible costs.
3. This will result in reduced costs, due to fewer staff required to complete the same process, higher competence, by eradicating process steps such as loops and bottlenecks, greater precision, by including checkpoints and success measures to make sure process steps are completed precisely, better understanding by all employees to fulfil their department objectives.
4. Process planning deals with the selection of the processes and the determination of conditions of the processes.

3.Syllabus

Unit-I: Introduction To Process Planning

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection

Unit-II: Process Planning Activities

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

Unit-III: Introduction To Cost Estimation

Importance of costing and estimation – methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labour cost, material cost- allocation of overhead charges- Calculation of depreciation cost.

Unit-IV: Production Cost Estimation

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

Unit-V: Machining Time Calculation

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

Text Books:

1. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
2. Sinha B.P, "Mechanical estimating and Costing", Tata-McGraw Hill publishing co, 1995.

Reference Books:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9 th Edition, John Wiley, 1998.
3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.

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4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001. 5. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME558.1	(Apply) Select the process, equipment and tools for various industrial products.
R19ME558.2	(Analyze) prepare process planning activity chart.
R19ME558.3	(Analyze) Explain the concept of cost estimation.
R19ME558.4	(Apply) Compute the job order cost for different type of shop floor.
R19ME558.5	(Analyze) Calculate the machining time for various machining operations.

VERTICAL 6 - GREEN ENERGY TECHNOLOGIES

R19ME561	**Renewable Energy Technologies**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1.Course Description:					
Renewable Energy course is offered at both undergraduate and postgraduate levels. The Renewable Energy course will deal with the study of renewable sources like natural resources, sunlight, geothermal heat, wind, or hydro power. Students pursuing renewable energy courses will equip themselves with a comprehensive understanding of all the natural resources. Students will also learn about the various applications of renewable energy and technologies used for extracting natural resources. Renewable energy courses give knowledge about various topics such as extracting natural resources, environmental studies, sustainable energy, and renewable energy management.					
2. Course Objectives:					
1. To know the Indian and global energy scenario 2. To learn the various solar energy technologies and its applications. 3. To educate the various wind energy technologies. 4. To explore the various bio-energy technologies. 5. To study the ocean and geothermal technologies.					
3.Syllabus					
Unit-I: Energy Scenario					

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Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans
Unit-II: Solar Energy
Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.
Unit-III: Wind Energy
Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.
Unit-IV: Bio-Energy
Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.
Unit-V: Ocean And Geothermal Energy
Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.
Text Books:
1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636 2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707
Reference Books:
1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K.,2012. 2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003. 3. Sukhatme. S.P., “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009. 4. Tiwari G.N., “Solar Energy – Fundamentals Design, Modelling and applications”, AlphaScienceIntlLtd,2015. 5. Twidell, J.W. & Weir A., “Renewable Energy Resources”, EFNSpon Ltd., UK, 2015.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME561.1	(Apply) Discuss the Indian and global energy scenario.
R19ME561.2	(Analyze) Describe the various solar energy technologies and its applications.
R19ME561.3	(Analyze) Explain the various wind energy technologies.
R19ME561.4	(Apply) Explore the various bio-energy technologies
R19ME561.5	(Analyze) Discuss the ocean and geothermal technologies.

R19ME562	**Energy Conservation In Industries**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course provides students with a widespread understanding on energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign with theoretical knowledge and practical applications. Through a structured curriculum encompassing lectures and demonstrations, students will develop proficiency in enegy audit, as well as mastering in energy management system.

2.Course Objectives:

1. Learn and quantifying the energy demand and energy supply scenario of nation
2. Analysing various factors behind energy billing and applying the concept of demand
3. Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses

3.Syllabus

Unit-I: Introduction To Energy

Energy scenario of World, India and TN: Environmental aspects of Energy Generation, Material and Energy balancing, Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

Unit-II: Electrical Supply Systems

Electricity Tariff structures: Typical Billing , Demand Side Management ,HT and LT supply , Power Factor , Energy conservation in Transformers , Harmonics

Unit-III: Energy Conservation In Major Thermal Utilities

Stoichiometry, Combustion principles: Energy conservation in: Boilers, Steam Distribution Systems, Furnaces, Thermic Fluid Heaters, Cooling Towers, D.G. sets. Insulation and Refractories, Waste Heat Recovery Devices.

Unit-IV: Energy Conservation In Major Electrical Utilities

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Energy conservation in: Motors, Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems, Illumination systems.
Unit-V: Energy Monitoring, Targeting, Labelling And Economics
Elements of Monitoring & Targeting System : CUSUM , Energy , Cost index diagram ,Energy Labelling , Energy Economics ,Cost of production and Life Cycle Costing , Economic evaluation techniques , Discounting and Non-Discounting ,ESCO concept , PAT scheme.
References:
Text Books:
1. Guide book for National Certification Examination for "Energy Managers and Energy Auditors" (Fourth Volume). 2. K.Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers & Dist, 2007.
Refrences: **Reference Books:** 1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006. 2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7thEdition, The Fairmont Press, 2013. 3. Murphy.W.R. and McKay.G, "Energy Management", Butterworth, London 1982. 4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981. 5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009. **Video References:** 1. https://www.youtube.com/watch?v=N7QroqcUeIo 2. https://www.youtube.com/watch?v=elAvjPWr8mI

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME562.1	Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
R19ME562.2	Analyze factors behind energy billing and apply the concept of demand side management for lowering energy costs
R19ME562.3	Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
R19ME562.4	Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
R19ME562.5	Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

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R19ME563	Energy Storage Devices	L	T	P	C
		3	0	0	3

1.Course Description:

The emerging energy generation sources such as solar and wind generates energy in variable Patterns. Hence, energy storage is becoming of major importance to store and supply energy Without any interruption. The energy storage can be in mechanical, electrochemical, or chemical forms. Smaller energy storage systems are also discussed for benchmarking and comparisons. Topics covered include electrical, chemical, thermal, mechanical, electrochemical, thermochemical and thermomechanical energy storage systems as well as grid integration issues.

2. Course Objectives:

1. To provide a foundation for understanding the general principles and fundamentals of Li-Ion battery technology design and operation.
2. To understand the expectancy of the hydrogen as a fuel and energy vector in the context of the renewable energy without CO2.
3. To learn basic electrochemical principles of the hydrogen fuel cells, basic fuel cell design concepts, fuel cell systems concepts.

3.Syllabus

Unit-I: Introduction

Need for energy storage; Introduction to Energy Storage Requirements, Different modes of energy storage; Utilization of energy storage devices, Different types of energy storage; Mechanical, Chemical, Electrical, Electrochemical, Biological, Magnetic, Electromagnetic, Thermal; Comparison of energy storage technologies.

Unit-II: Thermal Energy Storage

Thermal energy storage - Necessity, latent heat storage system, Phase Change Materials (PCMs) and classifications, properties of the PCM's for different temperature range, selection criteria of PCMs for heating and cooling in buildings, PCM's use in Solar dryer, water heating system, LHTES systems in refrigeration and air-conditioning applications; Short term heat storage system, Heat storage in SHS systems; SHS mediums, Rock-bed storage systems; Energy analysis of the latent heat storage based different systems

Unit-III: Electrical Energy Storage

Flywheel and compressed air storage; Pumped hydro storage; Hydrogen energy storage, Electrical Energy Storage (EES) Technologies and Considerations: Flywheel Energy Storage System (FESS) and Applications;, Electrical and magnetic energy storage; Capacitor Energy Storage Systems,

Unit-IV: Thermo & Electrochemical Energy Storage

Thermo chemical energy stprage; Hydrogen as energy carrier and storage; Hydrogen resources and production; Basic principle of direct energy conversion using fuel cells; Thermodynamics of fuel cells Fuel cell types: AFC, PEMFC, MCFC, SOFC, Microbial Fuel cell; Electrochemical Energy Storage; Battery – fundamentals and technologies, characteristics and performance comparison: Lead-acid, Nickel-Metal hydride, Lithium Ion; Battery system model, emerging trends in batteries.

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Unit-V: Application Of Energy Storage
Case studies and application of the thermal energy storage for space heating and cooling, green house heating, Solar power plant applications; Drying and heating for process industries, Food preservation; Waste heat recovery; Comparison of different energy storage technologies and future prospects. Application of Energy Storage: Food preservation, Waste heat recovery, Solar energy storage: Greenhouse heating; Drying and heating for process industries.
Text Books:
1. Ataer, O. Ercan. Energy Storage Systems-Volume I (2009): 97, Encyclopedia of Life Support Systems. 2. Kalaiselvam, S., and R. Parameshwaran. Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications. Elsevier.
Reference Books:
1. Fleischer, Amy S. Thermal Energy Storage Using Phase Change Material, Springer. 2. Lithium-Ion Batteries Basics and Applications by Reiner Korthauer, Springer. 3. Fuel cells from fundamentals to applications by Supramaniam Srinivasan, Springer.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME563.1	**(Understand)** Understand the different types of the energy storage systems.
R19ME563.2	**(Analyze)** Analyze different PCM's based energy storage systems including latent heat storage systems and sensible heat storage systems.
R19ME563.3	**(Analyze)** Analyze the importance of chemical energy storage and hydrogen energy storage.
R19ME563.4	**(Understand)** Acquire knowledge for compressed air energy storage, electrical and magnetic energy storage systems.
R19ME563.5	**(Analyze)** Will be able to investigate the construction and working principles of batteries and fuel cells

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R19ME564	Equipment For Pollution Control	L	T	P	C
		3	0	0	3

1. Course Description

Comprehensive overview of the technologies and equipment used in managing and mitigating pollution across various environments. Students will explore the principles and mechanisms of equipment designed for controlling water, air, and solid waste pollution. Also emphasizes the latest advancements in pollution control technology and their applications in real-world scenarios.

2. Course Objectives:

1. To explore the regulations and standards related to controlling pollution in water and wastewater.
2. To examine various equipment used for addressing water pollution.
3. To investigate different types of equipment for managing air pollution.
4. To Analyze the equipment involved in processing solid waste & Other types of waste .
5. To learn about the equipment used for monitoring different types of pollution.

3. Syllabus

Unit-I: Pollution Control Regulations And Standards

Pollutants in water and wastewater – sources and impacts- Characteristics and impacts of solid and hazardous wastes – Indian Constitution and Environmental Protection Legislations – Environmental Standards under different Environmental legislations – Water Act (1974), Air Act (1981), Environmental Protection Act (1986) and major Notifications, Municipal solid Wastes (Management and Handling) Rules - Bio Medical Wastes (Management and Handling) Rules – Hazardous Wastes (Management and Handling Rules), Environment Impact Assessment Notifications – Unit operations and unit processes in Pollution Control- – Selection criteria for Pollution Control Equipment.

Unit-II: Equipment For Water Pollution Control

Operational principles and Design criteria of Flash mixers, Flocculators, Clarifiers, Sand Filters, Adsorption Columns, Aerators, Air blowers, Distillation units, Centrifugal and Reciprocating Pumps, Chemical dosing systems, Motors, Pipes, valves and Fittings.- Filed visit to a wastewater treatment plant

Unit-III: Equipment For Air Pollution Control

Operational principles and Design criteria of Cyclone separators, gravity settlers, Wet Scrubbers, Air strippers, Bag Filters, Electrostatic precipitators, Bio filters - Filed visit to an industry with air pollution control systems

Unit-IV: Equipment For Solid Waste Processing

Operational principles and Design criteria of Dewatering equipment - Centrifuge, Vacuum Filter, Filter Press- Size Reduction equipment- shredders, grinders - Trommel and Disc Screens - Air Classifiers - bailing and briquetting - incinerators -Pyrolysis - Field visit to a solid waste processing facility – E-Waste, Batteries; Bio Medical waste – Plastic Waste

Unit-V: Pollution Monitoring Equipment

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Equipment's for sampling of water, solids and air- Sample preservation Equipment – incubators -Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gas sampling and monitoring equipment
Text Books:
1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015. 2. Rao. C.S (2006)., Environmental Pollution and Control Engineering, 2nd Edition, Revised, Wiley Eastern Limited, India.
References Books:
1. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001 2. Metcalf & Eddy, INC, Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014. 3. Noel de Nevers, "Air Pollution Control Engg", Mc Graw Hill, New York, 2016. 4. CPCB (2021), "Pollution Control Acts, Rules and Notifications issued thereunder, PCL Series- Central Pollution Control Board, Delhi 5. CPHEEO, Manual on Municipal Solid waste management,Vol I, II and III, Central Public Health and Environmental Engineering Organisation , Government of India, New Delhi, 2016.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME564.1	To understand the key pollution control regulations and their relevance to various environmental media, such as water, air, and soil across different industries and sectors.
R19ME564.2	To apply knowledge of water pollution control equipment to solve practical problems in water quality management using various water pollution control devices, such as filtration systems, sedimentation tanks, and chemical treatment units
R19ME564.3	To evaluate the impact of air pollution control equipment on overall air quality and environmental health.
R19ME564.4	To Investigate innovative solid waste processing techniques and equipment to improve sustainability and minimize negative environmental impacts.
R19ME564.5	To Assess the cost-effectiveness and efficiency of different monitoring equipment, taking into account long-term maintenance and operational expenses.

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R19ME565	Energy Efficient Buildings	L	T	P	C
		3	0	0	3

1. Course Description

To understand the sustainable design principles and practices in the construction and operation of energy efficient buildings. Also covers energy conservation and efficiency, including the design of building envelopes, HVAC systems, lighting, and renewable energy integration.

2. Course Objectives:

1. To learn the green buildings concepts applicable to alternate design
2. To be familiar with basic terminologies related to buildings
3. To learn the building(air)conditioning techniques
4. To know the methods to evaluate the performance of buildings
5. To incorporate Renewable energy systems in buildings

3. Syllabus

Unit-I: Introduction

Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards

Unit-II: Land Scape And Building Envelopes

Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity(DHC),ThermalLag, Decrement Factor, Effect of Solar Radiation –Sol-air Temperature, Processes of heat exchange of building with environment, Insulation.

Unit-III: Passive Heating And Cooling

HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Day lighting, Passive Cooling–Natural Ventilation(Stack and Wind),Evaporative Cooling and Radiative Cooling.

Unit-IV: Thermal Performance Of Buildings

Heat transfer due to fenestration / infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

Unit-V: Renewable Energy In Buildings

Introduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, stand- alone PV systems, Hybrid system–Economics.

Text Books:

1. Jan F. Kreider, Peter S.Curtiss, Ari Rabl, Heating and cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press,28-Dec-2009.

References Books :

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1. ASHRAEHandbook-2009-Fundamentals.
2. Baruch Givoni: Climate considerationsinbuildingandUrbanDesign,JohnWiley&Sons,1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by,John Wiley & Sons,15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley& Sons, 2006.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME565.1	To Create designs for climate-responsive buildings
R19ME565.2	To Identify and understand different physical properties that affect passive building design.
R19ME565.3	To Utilize passive (air) conditioning techniques in the construction of energy-efficient buildings
R19ME565.4	To Evaluate and analyze the energy performance of buildings.
R19ME565.5	To Assess and evaluate the incorporation of renewable energy systems in buildings.

R19ME566	Bio Energy Conversion Technologies	L	T	P	C
		3	0	0	3

1.Course Description:

Energy conversion technology is concerned with the transformations of energy from forms provided by nature to convenient or useful forms of energy. Harnessing the energy through these sources using efficient technologies is expected to play an important role in serving as clean energy source for mankind. This course covers fundamentals of such energy conversion systems with a broad perspective that encompasses technical and environmental aspects. This course aims at providing the recent advancement and technological developments (carbonization, sub and supercritical water gasification, thermochemical conversion to ethanol, green diesel) in the field of conventional (coal) and non-conventional energy sources (biomass) with emphasis on engineering and design aspects and concept of integration of energy system.

2. Course Objectives:

1. To learn availability of biomass, methods of biomass analysis and study of characteristics.
2. To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3. To impart knowledge on stoichiometry and combustion of biofuels and costing of biomass technologies
4. To elucidate the thermo chemical conversion methods of biomass and its use in engines
5. To provide insight to the possibilities of producing liquid fuels form biomass

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3.Syllabus
Unit-I: Biomass Resources
Biomass: definition, classification, types–advantages and drawbacks–Indian scenario–characteristics– conversion mechanisms–fuel assessment studies–Availability and estimation, Consumption and surplus biomass, Energy Plantation, Potential of biomass and assessment, thermal properties : Proximate, Ultimate and heating value analysis – Biomass pre-treatment processes – Biodiesel and bio-ethanol : Sources and extraction methods.
Unit-II: Processing Of Biomass
Physical properties of biomass: Moisture, bulk density, size, grindability, crushability. Chemical composition of biomass- estimation of volatile matter, cellulose and lignin content. Properties of municipal solid waste – MSW management principle – Segregation of waste biomass – refuse derived fuels. Pelleting and briquetting of solid biomass – Process flow – factors influencing heat values. Pre-treatment of biomass for energy enhancement – Torrefaction
Unit-III: Thermo-Chemical Conversion
Direct combustion, Incineration, Pyrolysis and Gasification, Biomass stoves, Design construction and operation of biomass combustors including incinerators, Biomass fired boilers and types, Biomass Pyrolysis types, Manufacture of charcoal, Manufacture of pyrolytic oils and gases, Design, Construction and operation of pyrolysis units, Biomass gasification types, Gasifier burner arrangement for thermal heating, Gasifier engine arrangement for electrical power, Design, construction and operation of gasifiers
Unit-IV: Biological-Chemical Conversion
Phases in biogas production – parameters affecting gas production – possible feed stocks. Biogas plants – types – design –constructional details and comparison – biogas appliances – burner, luminaries and power generation –, Economies of biogas plant, Bioconversion of substrates into alcohol, Production of methanol and ethanol, Hydrolysis and hydrogenation, solvent Extraction of hydrocarbons, Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-equivalence ratio – fixed Bed and fluid Bed combustion
Unit-V: Liquefied Biofuels
History, Biomass potential in India, Production and methods of biodiesel, Transesterification, fuel properties, History of usage of Straight Vegetable Oil as fuel – Biodiesel production from oil seeds, waste oils and algae – Process and chemistry – Biodiesel health effects, Biodiesel power generation and techniques / emissions /performance. –engine modifications
Text Books:
1. David Boyles,Bio Energy Technology Thermodynamics and costs, Ellis Horwood Chichester,1984. 2. Iyer PV Retal, Thermo chemical Characterization of Biomass, MNES 3. KhandelwalKC, Mahdi SS, Biogas Technology–A Practical Handbook,Tata McGraw Hill,1986
References Books

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1. Maheswari,R.C. BioEnergy for Rural Energisation, Concepts Publication,1997
2. Tom B Reed, Biomass Gasification–Principles and Technology, Noyce Data Corporation,1981.
3. Bioenergy: Biomass to Biofuels and Waste to Energy, Academic Press,2020
4. 4. David C. Dayton , Thomas D. Foust ,Analytical Methods for Biomass Characterization and Conversion (Emerging Issues in Analytical Chemistry), Elsevier,2019

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME566.1	**(Evaluate)** Estimate the availability of surplus biomass and study the characteristics.
R19ME566.2	**(Understand)** Understand technical and economic feasibility and sustainability of energy production from biomass
R19ME566.3	**(Evaluate)** Determine and compare the cost of steam generation from biofuels with conventional fuels.
R19ME566.4	**(Analyze)** Analyze the influence of process governing parameters in thermo chemical conversion of biomass and in internal combustion engines
R19ME566.5	**(Analyze)** Analyze the production of liquid biofuels for power generation from biomass

R19ME567	Renewable Powered Off Highway Vehicles	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides students with a wide ranging knowledge on green energy production methodologies and its applications on off-road vehicle categories. Through a structured curriculum encompassing lectures and demonstration, students will develop proficiency in designing for off-road vehicle applications.

2.Course Objectives:

1. To study the low and zero carbon fuels suitability and methods of use in off-road vehicles
2. To learn and understand the green energy production methodologies and its use in off-road vehicle categories.
3. To learn various fuel cell types and its suitability in off-highway vehicles applications.
4. To illustrate the impact of in-cylinder technologies on engine out emissions control.
5. To study the existing after-treatment technologies used in off-highway vehicle applications.

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3.Syllabus
UNIT-I: Low And Zero Carbon Fuels Powered Off-Highway Vehicles
Ethanol, Methanol, Butanol, Biodiesel, CNG, LNG, DME, Polyoxymethylene Dimethyl Ether (PODE), Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.
Unit-II: Green Energy Powered Off-Highway Vehicles
Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.
Unit-III: Fuel Cell Powered Off-Highway Vehicles
Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell,research on Off-road vehicle applications.
Unit-IV: In-Cylinder Treatment Technologies
Low temperature Combustion Modes ,Homogeneous Charge Compression Ignition, Premixed-Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection, Compression Ignition, Water Injection Technologies.
Unit-V: After Treatment Technologies
Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip /clean up catalyst. CO_2 absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.
References:
Text Books: 1. John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015, 2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.
Refrences: **Reference Books:** 1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 , Technology & Engineering. 2. W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control. 3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill , 1 June 2011. 4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. ,7 April 2022. 5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite , 21 December 2017. **Web References:**

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1. https://www.pnw.edu/wp-content/uploads/2020/03/solar_vehicle_me439_final_paper_v2.pdf.
2. 2.https://www.washingtonpost.com/climate-solutions/interactive/2021/solar-car/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME567.1	Evaluate the availability, suitability, and its role in off-road vehicle categories in reducing the carbon footprint on the environment.
R19ME567.2	Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.
R19ME567.3	Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.
R19ME567.4	Gain the knowledge on various in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.
R19ME567.5	Develop the working of various existing after treatment systems in controlling the engine out emissions.

R19ME568	Thermal Management Of Batteries And Fuel Cells	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides students with a comprehensive understanding of battery thermal management systems and fuel cells with theoretical knowledge and practical applications. Through a structured curriculum encompassing lectures and demonstrations, students will develop proficiency in designing, battery pack, as well as mastering in thermal management in battery management system.

2.Course Objectives:

1. To learn the basic concepts of Li-ion Battery terminologies and it working principle

1. To realize the need of battery management system (BMS) and its functions.
To develop the different case studies in Battery Thermal Management System.
To familiar the design procedure of battery pack.
To familiarize the working principle of fuel cells and its cooling methods.

3.Syllabus

Unit-I: Advanced Batteries

Li-ion Batteries, chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Super capacitors Vs batteries. Diamond battery concept.

Unit-II: Thermal Management in Batteries

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Thermal Management Systems, impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types-Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.
Unit-III: Battery Thermal Management Case Studies
EV Battery Cooling, challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs, system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics, simulation concepts.
Unit-IV: Thermal Management In Fuel Cells
Fuel Cells, operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.
Unit-V: Fuel Cell Thermal Management Case Studies
Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV, Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refuelling, Case studies.
Text Books:
1. Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", Wiley, 2017. 2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles", Wiley, 2015. 3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design", CRC Press, 2005. 4. John G. Hayes and G. Abas Goodarzi, "Electric Powertrain", Wiley, 2018. **5.** Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.
References: **Reference Books:** 1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013. 2. Younes Shabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press. 3. T.Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE International. 4. Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, Mc Graw- Hill. **Web References:**

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1. https://liu.diva-portal.org/smash/get/diva2:1676199/fulltext01.pdf
2. https://publications.lib.chalmers.se/records/fulltext/200046/200046.pdf

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME568.1	Recognize the concepts of Li-ion Batteries and Fuel Cell performances.
R19ME568.2	Design a Battery Pack with appropriate software
R19ME568.3	Apply Cooling Models using Simulation
R19ME568.4	Estimate the fuel economy.
R19ME568.5	Utilize different Thermal Management System approaches during real world usage

VERTICAL 7 - ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

R19ME571	**Generative AI for Engineering Design**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

Generative AI for Engineering Design" explores the integration of generative artificial intelligence techniques within the engineering design process. This course provides a thorough understanding of how generative models, such as Variational Auto encoders (VAEs) and Generative Adversarial Networks (GANs), can be applied to create innovative and optimized engineering designs. Students will engage with both theoretical concepts and practical implementations, gaining hands-on experience with state-of-the-art tools and methodologies. The course emphasizes the use of AI-driven design to solve complex engineering problems, improve efficiency, and foster creativity in design processes.

2. Course Objectives:

1. Fundamental Understanding: To introduce students to the foundational concepts and techniques of generative AI and their applications in engineering design.
2. Technical Proficiency: To develop students' skills in implementing and utilizing generative models using Python and relevant libraries such as Tensor Flow and PyTorch.

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3. Design Integration: To teach students how to integrate generative AI techniques into the engineering design process, including data preparation, model training, and optimization.
4. Problem-Solving Skills: To enhance students' ability to apply generative AI methods to real-world engineering problems, fostering innovative and optimized solutions

3.Syllabus

Unit-I: Introduction to Generative AI in Engineering Design

Overview of Generative AI: History, definitions, and key concepts; Applications in Engineering Design: Use cases in various engineering fields (mechanical, civil, electrical, etc.);Benefits and Challenges: Advantages of using generative AI in design, potential challenges, and ethical considerations;

Unit-II: Fundamental Techniques of Generative AI

Deep Learning Basics: Neural networks, backpropagation, and gradient descent; Generative Models: Introduction to Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), and other generative models; Algorithm Implementation: Hands-on exercises with Python libraries such as Tensor Flow and PyTorch ;

Unit-III: Data for Generative Design

Data Collection and Preparation: Techniques for gathering and preprocessing design data; Feature Engineering: Identifying and engineering features relevant to engineering design; Dataset Augmentation: Methods for augmenting datasets to improve model performance;

Unit-IV: Advanced Generative Design Techniques

Optimization Algorithms: Genetic algorithms, particle swarm optimization, and other heuristic methods; Topology Optimization: Techniques for optimizing material distribution within a given design space; Multi-objective Optimization: Balancing multiple design criteria using Pareto front optimization;

Unit-V: Simulation and Validation of Generative Designs

Simulation Tools: Introduction to simulation software and tools commonly used in engineering design (e.g., ANSYS, SolidWorks); Model Validation: Techniques for validating the performance and reliability of generative designs; Iterative Design Process: Integrating simulation feedback into the generative design loop for continuous improvement;

Text Books:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning," MIT Press, 2016.
2. David Foster, "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play," O'Reilly Media, 2019.
3. Christopher M. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006.
4. Melanie Mitchell, "Artificial Intelligence: A Guide for Thinking Humans," Farrar, Straus and Giroux, 2019.
5. Patrick Hebron, "Machine Learning for Designers," O'Reilly Media, 2016.

Reference Books:

1. Martin Philip Bendsoe and Ole Sigmund, "Topology Optimization: Theory, Methods, and Applications," Springer, 2003.

2. Suvrit Sra, Sebastian Nowozin, and Stephen J. Wright (editors), "Optimization for Machine Learning," MIT Press, 2012.
3. Benedikt Gross and Hartmut Bohnacker, "Generative Design: Visualize, Program, and Create with JavaScript in P5.js," Princeton Architectural Press, 2018.
4. Gerhard Pahl, Wolfgang Beitz, Jörg Feldhusen, and Karl-Heinrich Grote, "Engineering Design: A Systematic Approach," Springer, 2007.
5. Averill M. Law, "Simulation Modeling and Analysis," McGraw-Hill, 2014.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME571.1	Understand the key concepts and terminologies related to generative AI and engineering design.
R19ME571.2	Explain the functioning of different generative models such as Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs).
R19ME571.3	Apply data collection, preprocessing, and augmentation techniques to prepare datasets for generative design
R19ME571.4	Implement generative models using Python and libraries such as TensorFlow and PyTorch.
R19ME571.5	Evaluate the impact of different optimization techniques on the efficiency and effectiveness of generative designs.

R19ME572	Machine Diagnostics and Condition Monitoring	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive study of techniques and sensors used in monitoring machine condition, including vibration analysis, thermography, and signal processing methods. Students learn about fault diagnostics, failure analysis, and maintenance principles, supported by case studies spanning various industries from manufacturing to marine and aerospace sectors. The course equips students with essential skills in machine learning and systematic fault monitor selection for effective condition-based maintenance strategies.

2.Course Objectives:

1. To understand the basics of various condition monitoring methods.
2. To identify the selection of condition monitoring sensors for various applications.
3. To study various signal processing for condition monitoring applications.
4. To know about various failure analysis, maintenance and machine learning.
5. To provide a basic understanding with case studies on different fault diagnosis method.

3.Syllabus

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Unit-I: Condition Monitoring Techniques and Machine Condition Monitoring
Condition Monitoring in manufacturing industries: Noise monitoring, Wear and debris Analysis, Thermography, Cracks monitoring, Ultrasonic techniques; Case studies: Vibration, Acoustic emission and vibro acoustics signal analysis; intelligent fault detection system: Case studies.
Unit-II: Sensors for Fault Diagnostics
Introduction: Contaminant monitoring sensors, Corrosion monitoring sensors, Force monitoring sensors, Gas leakage monitoring sensors, Air pollution monitoring sensors, Liquid contamination monitoring sensors; Non-destructive testing techniques: Optical examination ,Temperature sensing
Unit-III: Signal Processing and Analysis
Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions. Time domain and Frequency domain and Time frequency domain analysis.
Unit-IV: Failure Analysis, Maintenance and Machine Learning
Maintenance Principles, Failure mode analysis ; Equipment down time analysis, Breakdown analysis, condition based maintenance,Vibration, Acoustic emission and vibrio-acoustics signal analysis; Intelligent fault detection system, Case studies.
Unit-V: Monitoring Systems Case Studies
Introduction: Marine monitoring systems, Marine turbine monitoring systems, Shipboard vibration monitoring, Monitoring integrity verification, Aircraft condition monitoring, Condition monitoring; Automotive diagnostic equipment ; Systematic fault monitor selection
Text Books:
1. R. A. Collacott, "Mechanical Fault Diagnosis and condition monitoring", Springer, 2011.Chapman and Hall London A Halstead Press Book John Wiley & Sons, New York
Reference Books: 1. W.H. Tang, Q.H. Wu ,"Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence", Springer, 2011. **Web Resources:** **1.** https://onlinecourses.nptel.ac.in/noc22_me60/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME572.1	Understand the basics of various condition monitoring methods.
R19ME572.2	Select suitable condition monitoring sensors for various applications.
R19ME572.3	Recall various signals processing for condition monitoring applications.
R19ME572.4	Know about various failure analysis, maintenance and machine learning.
R19ME572.5	Apply different fault diagnosis method for various applications

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R19ME573	Exploratory Data Analysis and Visualization	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive introduction to exploratory data analysis (EDA) techniques. focusing on fundamental principles and practical applications using Python. Students will learn the significance of EDA in data science, along with comparing EDA methodologies with classical and Bayesian analysis approaches. Students will explore various data manipulation and transformation techniques using the Pandas library, including data indexing, handling missing data, hierarchical indexing, and combining datasets. Additionally, this course covers univariate and bivariate analysis methods, including distribution variables, scaling, standardizing, percentage tables, and scatterplots. Furthermore, students will delve into multivariate and time series analysis concepts, including causal explanations, time series data characteristics, data cleaning, time-based indexing, visualizing, grouping and resampling, preparing them for data exploration and analysis tasks in real-world scenarios.

2. Course Objectives:

1. Outline an overview of exploratory data analysis.
2. Implement data visualization using Python.
3. Perform univariate, bivariate, Multivariate data exploration and time series analysis.

3. Syllabus

Unit-I: Exploratory Data Analysis

EDA: Fundamentals, Understanding data science, Significance, Making sense of data, Comparing EDA with classical and Bayesian analysis, Software tools, Visual Aids, Data transformation techniques, merging database, reshaping and pivoting, Transformation techniques.

Unit-II: EDA using Python

Data Manipulation using Pandas: Pandas Objects, Data Indexing and Selection, Operating on Data, Handling, Missing Data; Hierarchical Indexing; Combining datasets: Concat, Append, Merge, Join; Aggregation, grouping; Pivot Tables; Vectorized String Operations.

Unit-III: Univariate Analysis

Single variable: Distribution Variables, Numerical Summaries of Level and Spread, Scaling & Standardizing, Inequality.

Unit-IV: Bivariate Analysis

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Relationships between Two Variables; Percentage Tables; Analysing Contingency Tables; Handling Several Batches: Scatterplots, Resistant Lines.
Unit-V: Multivariate And Time Series Analysis
Introducing a Third Variable: Causal Explanations, Three-Variable Contingency Tables & Beyond; TSA: Fundamentals, Characteristics of time series data, Data Cleaning, Time-based indexing, Visualizing, Grouping, Resampling.
Text Books:
1. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", Packt Publishing, 2020. 2. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", First Edition, O Reilly, 2017. 3. Catherine Marsh, Jane Elliott, "Exploring Data: An Introduction to Data Analysis for Social Scientists", Wiley Publications, 2nd Edition, 2008.
References:
1. Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017 2. Claus O. Wilke, "Fundamentals of Data Visualization", O'reilly publications, 2019. 3. Matthew O. Ward, Georges Grinstein, Daniel Keim, "Interactive Data Visualization: Foundations, Techniques, and Applications", 2nd Edition, CRC press, 2015. **MOOC/SWAYAM/NPTEL Courses:** **1.** https://onlinecourses.nptel.ac.in/noc22_cs32/preview **2.** https://archive.nptel.ac.in/courses/106/106/106106212/ 3. https://youtube.com/playlist?list=PLyqSpQzTE6M_fFg1zZmeGIkenMDgXKGYi&feature=shared

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME573.1	Understand the fundamentals of exploratory data analysis.
R19ME573.2	Implement the data visualization using Python.
R19ME573.3	Perform univariate data exploration and analysis.
R19ME573.4	Apply bivariate data exploration and analysis.
R19ME573.5	Use Data exploration and visualization techniques for multivariate and time series data

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R19ME574	IoT Systems and Design	L	T	P	C
		3	0	0	3

1.Course Description:

This course delves into the fundamentals of the Internet of Things (IoT), covering its evolution, enabling technologies, and architectural models. Students explore IoT components, including sensors, actuators, and communication modules, and learn about key protocols and technologies driving IoT deployments. Practical aspects, such as programming for IoT platforms like Raspberry Pi and Arduino, are emphasized, along with real-world applications across various sectors like smart cities, industrial IoT, and home automation.

2. Course Objectives:

1. To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
2. To teach a student how to analyses requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
3. To introduce the technologies behind Internet of Things (IoT).
4. To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.

3.Syllabus

Unit-I: Introduction to Internet of Things

Evolution of Internet of Things; Enabling Technologies; IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models; Simplified IoT Architecture and Core IoT Functional Stack: Fog, Edge and Cloud in IoT

Unit-II: Components in Internet of Things

Functional Blocks of an IoT Ecosystem: Sensors, Actuators, and Smart Objects; Control Units ; Communication modules: Bluetooth, Zigbee,Wifi, GPS, GSM Modules

Unit-III: Protocols and Technologies Behind IoT

IOT Protocols: IPv6, 6LoWPAN, MQTT, CoAP, RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

Unit-IV: Open Platforms and Programming

IOT deployment for Raspberry Pi /Arduino platform: Architecture, Programming, Interfacing; Accessing GPIO Pins: Sending and Receiving Signals Using GPIO Pins, Connecting to the Cloud.

Unit-V: IOT APPLICATIONS

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance; Home Automation; Smart Agriculture

Text Books:

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1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017 2. Samuel Greengard, The Internet of Things, The MIT Press, 2015
Reference Books:
1. Perry Lea, "Internet of things for architects", Packt, 2018 2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012 3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition. 4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011. 5. ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME574.1	Understand the concept of IoT.
R19ME574.2	Understand the communication models and various protocols for IoT.
R19ME574.3	Design portable IoT using Arduino/Raspberry Pi /open platform.
R19ME574.4	Apply data analytics and use cloud offerings related to IoT.
R19ME574.5	Analyze applications of IoT in real time scenario.

R19ME575	**Microsystem Design & Application**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

Microsystem Design & Application" is a comprehensive course that delves into the principles, design methodologies, and applications of microsystems. Microsystems, often referred to as Micro-Electro-Mechanical Systems (MEMS), integrate mechanical, electrical, and computational elements at a micro-scale. This course covers the fundamentals of

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microsystem design, fabrication techniques, material selection, and various application areas such as sensors, actuators, and biomedical devices. Students will gain hands-on experience in designing and simulating microsystems, understanding their real-world applications, and exploring future trends and innovations in the field.

2. Course Objectives:

1. Fundamental Understanding: To provide students with a solid foundation in the principles and concepts of microsystem design and fabrication.
2. Technical Proficiency: To equip students with the skills needed to design, simulate, and fabricate microsystems using industry-standard tools and techniques.
3. Application Insight: To expose students to various applications of microsystems in different industries, including healthcare, automotive, and consumer electronics.
4. Innovation and Creativity: To foster innovative thinking and problem-solving skills by challenging students to develop novel microsystem solutions for real-world problems.

3.Syllabus

Unit-I: Introduction to Micro Electromechanical Systems

Historical perspective, Development of MEMS Technology, MEMS Technology: Present, Future and Challenges MEMS Applications Comparison of MEMS and Microelectronics.

Unit-II: Fabrication Processes

Fabrication processes: Different Materials, Substrates, Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Etching Processes, Patterning, Wafer Bonding, Annealing, Chemical Mechanical Polishing (CMP), Material Doping

Unit-III: Sensors and Actuators

MEMS Actuators, MEMS Sensing, Electron Tunneling, Sensor Noise, MEMS Physical Sensors, Chemical Sensors

Unit-IV: Technologies in Microsystems & MICRO/NANO Bio Sensors

Bulk Micromachining, LIGA (Lithographie, Galvanoformung, Abformung), Sacrificial Surface Micromachining.

Classification of physical sensors, Integrated, Intelligent or Smart sensors, Bio sensing Principles and sensing methods, Biosensors arrays and Implantable devices.

Unit-V: Applications of Microsystems

Delivery of Diagnostic and Therapeutic Agents to Vascular Targets, Real-Time Biological Imaging and Detection, Diagnostic and Therapeutic Applications of Metal Nano shells, Micro devices for Oral Drug Delivery etc.

Text Books:

1. Stephen D. Senturia, "Microsystem Design," Springer, 2001.
2. Marc J. Madou, "Fundamentals of Microfabrication: The Science of Miniaturization," CRC Press, 2002.
3. Tai-Ran Hsu, "MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering," John Wiley & Sons, 2020.

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4. Mohamed Gad-el-Hak, "The MEMS Handbook," CRC Press, 2005. 5. Gregory T. A. Kovacs, "Micromachined Transducers Sourcebook," McGraw-Hill, 1998.
Reference Books:
1. Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical Systems Engineering," Artech House, 2004. 2. Sami Franssila, "Introduction to Microfabrication," John Wiley & Sons, 2010. 3. W. Trimmer (Editor), "Micromechanics and MEMS: Classic and Seminal Papers to 1990," IEEE Press, 1996. 4. Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Microsensors, MEMS, and Smart Devices," John Wiley & Sons, 2001. 5. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies," John Wiley & Sons, 2006.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME575.1	Define key concepts, terms, and principles related to microsystem design and fabrication.
R19ME575.2	Explain the processes involved in the design and fabrication of microsystems.
R19ME575.3	Apply design methodologies to create functional microsystem prototypes using CAD tools.
R19ME575.4	Implement simulation techniques to Analyze the performance of microsystem designs.
R19ME575.5	Compare different fabrication techniques and materials for specific microsystem applications

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R19ME576	Machine Vision	L	T	P	C
		3	0	0	3

1. Course Description:

This introductory course covers the basics of machine vision, focusing on image acquisition, pre-processing, feature extraction, and pattern recognition. Students explore real-world applications in industries such as manufacturing, healthcare, and security. By the course's end, students gain a foundational understanding of machine vision's role in automation and efficiency enhancement.

2. Course Objectives:

1. To understand the basics concepts of optics and vision systems.
2. To learn and understand the fundamentals of image processing
3. To impart knowledge on object recognition and feature extraction.
4. To understand algorithms in image processing.
5. 5. To demonstrate the various applications of machine vision system.

1. Syllabus

Unit-I: Image Acquisition

The Nature of Vision; Robot vision: Need, Applications; image acquisition; Physics of Light; Interactions of light; Refraction at a spherical surface; Thin Lens Equation; Illumination techniques: linear scan sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

Unit-II: Image Processing Fundamentals

Introduction to Digital Image Processing; Image sampling and quantization; Image enhancement: Gray Value Transformations; Radiometric Calibration; Image Smoothing; Geometric transformation; Image segmentation; Object Recognition and Image Understanding; Feature extraction: Region Features, Gray Value Features, Contour Features;Morphology;Edge extraction; Fitting and Template matching.

Unit-III: Object Recognition and Feature Extraction

Image segmentation; Edge Linking; Boundary Detection: Region growing: Region splitting and merging; Boundary Descriptors; Freeman chain code; Regional Descriptors; recognition structural methods; Recognition procedure; Mahalanobis procedure.

Unit-IV: Collison Fronts Algorithm

Introduction: skeleton of objects; Gradients; propagation: Definitions, propagation algorithm: Thinning Algorithm, Skeleton lengths of Top most objects.

Unit-V: Machine Vision Application

Case study: Automated Navigation guidance by vision system; vision based de palletizing; line tracking; Automatic part Recognition; Image processing techniques implementation through Image Processing software.

Text Books:

1. Rafael C. Gonzales, Richard. E. Woods, "Digital Image Processing Publishers", FourthEdition
2. EmanueleTrucco, Alessandro Verri, "Introductory Techniques For 3D Computer Vision",First Edition

References Books:

1. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, "An Invitation to 3-D Vision From Images to Models", First Edition, 2004
2. Fu .K.S, Gonzalez .R.S, Lee .C.S.G, "Robotics – Control Sensing, Vision and Intelligence", Tata McGraw-Hill Education, 2008.
3. RafelC.Gonzalez, Richard E.Woods,StevenL.Eddins, "Digital Image Processing using MATLAB", 2nd edition, Tata McGraw Hill, 2010.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME576.1	**(Understand)** Know the various types of sensors, lightings, hardware and concept of machine vision
R19ME576.2	**(Understand)** Acquire the image by the appropriate use of sensors, lightings and hardware.
R19ME576.3	**(Apply)** Apply the various techniques of image processing in real time applications.
R19ME576.4	**(Analyze)** Select the suitable sensors, lightings and hardware.
R19ME576.5	**(Apply)** Apply the vision techniques in Robot vision system.

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R19ME577	Haptics And Immersive Technologies	L	T	P	C
		3	0	0	3

1.Course Description:

This course provides an in-depth exploration of immersive technologies, including virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR). Students will gain a comprehensive understanding of the underlying concepts, hardware, and software tools necessary to develop immersive applications.

2.Course Objectives:

1. To familiarize on various immersive technologies of VR, AR and MR and allied softwares.
2. To learn the concepts of developing AR, VR applications and unreal engine.
3. To study the haptic perception and extended reality

3.Syllabus

Unit-I: Introduction to Immersive Technologies

Introduction on Immersive Technologies: Virtual reality, Augmented reality, Mixed reality, Extended reality, VR Devices, AR Devices; Applications.

Unit-II: Software Tools

Introduction to Unity: Unity editor workspace; Intro to C# and visual studio: Programming in Unity; Introduction to Unreal Engine: UE4 Editor workspace; Intro to Blueprint programming: Programming in UE4.

Unit-III: Building AR Application with Unity

AR SDKs (Software Development Kits) for unity and unreal engine:Working with SDKs for unity, Developing AR application in unity, Building AR application.

Unit-IV: Building VR Application with Unreal Engine

VR SDKs for unity and unreal engine: Developing VR application in Ue4, Building VR application

Unit-V: Haptic Perception and Extended Reality

Extended Reality: Introduction to Haptics, Devices and possibilities, Custom Device development, Device Integration.

Text Books:

1. Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10 : 1447162137
2. XR Haptics, Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs den Butter , RafalPijewski, March 13, 2022

Reference Books:

1. Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1st edition (8 September 2016).
2. Strategic Communication and AI, by Simon Moore, Roland Hübscher, Routledge; 1st edition (10 September 2021), ISBN-10 : 0367627795

3. Immersive Analytics, by Kim Marriott, Falk Schreiber, Springer; 1st ed. 2018 edition (15 October 2018). 4. Immersive Analytics A Clear and Concise Reference, by Gerardus Blokdyk, 5STARCooks (5 September 2018)

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME577.1	Apply the detailed knowledge about immersive technology in Automation.
R19ME577.2	Acquire the knowledge of different types of Software Tools and Devices in Immersive Technologies.
R19ME577.3	Acquire the knowledge about AR Unity and VR Unreal Engine
R19ME577.4	Develop the applications in immersive technologies
R19ME577.5	Explore about haptics in immersive technologies

R19ME578	**Advanced Statistics and Data Analytics**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

Advanced Statistics and Data Analytics course explores advanced methods for analyzing data, modeling relationships and making data-driven decisions effectively.

2. Course Objectives:

1. To study the basic concepts of linear regression and multiple regression.
2. To study the exploratory data analysis.
3. To study the logistic regression models for classification.
4. To study the development in the forecasting techniques for the predictions
5. To study the time series analysis for the prediction of future behavior

3.Syllabus

Unit-I: Regression

Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modelling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

Unit-II: Exploratory Data Analysis

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Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.
Unit-III: Logistic And Multinomial Regression
Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient.
Unit-IV: Forecasting And Causal Models
Moving average, Exponential Smoothing, Casual Models.
Unit-V: Time Series Analysis
Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Models
Text Books:
1. Douglas C Montgomery and George C Runges, "Applied Statistics and Probability for Engineers", John Wiley &Sons, 2014. 2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, "Introduction to Time Series Analysis and Forecasting" ,Wiley,2015
Reference Books:
1. David Forsyth, 'Probability and Statistics for Computer Science', Springer; 2018. 2. Michael J. Evans, Jeffrey S. Rosenthal, 'Probability and Statistics - The Science of Uncertainty'. W H Freeman & Co, 2010.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME578.1	**(Apply)** Develop how to do regression fit for the given data
R19ME578.2	**(Understand)** Visualize the data through explanatory data analysis
R19ME578.3	**(Analyze)** Classify the given data through logistic regression
R19ME578.4	**(Analyze)** Investigate forecasting techniques and causal inferences
R19ME578.5	**(Apply)** Utilize the effective time series analysis to predict/forecast the future behaviour of data.

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OPEN ELECTIVES

R19AD651	Data Science Essentials	L	T	P	C
		2	0	2	3

1. Course Description:

The course aims to provide students with a comprehensive understanding of data science, covering key concepts, methodologies, and tools essential for data analysis, interpretation, and decision-making. Students will learn to collect, preprocess, and analyze data from various sources using statistical techniques and machine learning algorithms. Students will gain practical experience in applying data science methods to real-world problems. By the end of the course, students will be equipped with the knowledge and proficiency needed to extract valuable insights from data, make informed decisions, and contribute effectively to the rapidly evolving field of data science.

2. Course Objectives:

1. Gain a foundational understanding of data science concepts and methods.
2. Develop the ability to collect, clean, and manage data.
3. Learn how to analyse data using statistical and machine learning techniques.
4. Develop the ability to solve real-world problems using data science.
5. Develop an understanding of the ethical implications of data science

3. Syllabus:

Unit-I: Introduction to Data Science and Data Acquisition

Data science: definition, scope, importance of data-driven decision making, interdisciplinary nature of data science, stages of data science life cycle; overview of data science tools and techniques, applications of data science; Data acquisition: Sources of data, data collection and API, web scraping: extracting data from websites, accessing different sources of data.

Unit-II: Data Exploration and Feature Engineering

Data analytics: descriptive analysis, diagnostic analytics, predictive analytics, predictive analytics; Data pre-processing: handling missing values – imputation techniques, dealing with outliers; Exploratory Data Analysis(EDA); Feature Engineering: One-hot encoding, label encoding, creating new features, dimensionality reduction techniques.

Unit-III: Data Visualization

Tableau: Introduction, Overview of Tableau interface and workspace; Features and advantages, connecting to data sources, importing data from local files and cloud storage services, creating basic visualizations in Tableau: Bar charts, line charts, scatter plots, pie charts, histograms, heatmaps, advanced visualization techniques in Tableau:Treemaps, bubble charts, box plots, dual-axis charts, combination charts, adding filters and parameters, building interactive dashboards in Tableau.

Power BI: Overview, connecting to data Sources in Power BI, Importing data from local files, databases, and web sources; creating basic visualizations in Power BI: Bar charts, line charts, scatter plots, pie charts, histograms, heatmaps; advanced visualization techniques in Power BI: Treemaps, bubble charts, box plots, dual-axis charts, combination charts, building interactive dashboards in Power BI.

Unit-IV: Statistical Concepts for Data Science

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Role of Statistics in Data Science; Population vs. Sample; Descriptive vs. Inferential statistics; Probability distributions: Poisson, Normal, Binomial, Uniform; Bayes' theorem and conditional probability; Descriptive statistics: Measures of central tendency: Mean, median, mode; Measures of dispersion: Variance, standard deviation; Inferential statistics: Hypothesis testing: Null and alternative hypotheses, p-values; Confidence intervals, ANOVA, Chi-square test, T-test; Correlation and Covariance.
Unit-V: Tools for Data Science
Microsoft Excel for data analysis: Introduction to Excel for basic data manipulation and analysis, data cleaning and formatting techniques in Excel, creating charts and graphs, pivot tables and pivot charts for summarizing and analyzing data, advanced Excel features for statistical analysis; Python packages for data science: NumPy for statistical analysis, data manipulation with Pandas data frames, data visualization using Matplotlib and Seaborn library.
List of Experiments:

1. Web Scrapping

   Use Case: Perform Web-Scrapping, create DataFrame by collecting the data from the website.

2. Exploratory Data Analysis: Perform Data Preprocessing & Data Wrangling on Netflix International Dataset

3. Exploratory Data Analysis: Perform EDA on Netflix International Dataset.

4. Fraud Detection in Financial Transactions

   Use Case: A banking institution aims to detect fraudulent transactions by analyzing historical transaction data.
   Experiment: Explore the dataset to identify patterns and anomalies indicative of fraudulent behavior. Develop new features such as transaction frequency, transaction amount, and geographical location. Apply anomaly detection techniques to flag suspicious transactions for further investigation.

5. Predictive Maintenance for Industrial Equipment

   Use Case: A manufacturing plant wants to implement predictive maintenance strategies to minimize downtime and optimize equipment performance.
   Experiment: Explore sensor data collected from industrial equipment to identify patterns associated with equipment failures. Engineer features such as equipment usage, temperature, and vibration levels. Train machine learning models to predict equipment failures before they occur based on historical sensor data.

6. Market Segmentation Analysis- Tableau

   Use Case: A beverage company is planning to launch a new health drink targeted towards health-conscious consumers. However, they recognize that the health-conscious market is diverse, with varying preferences and needs. To ensure the success of their product, they decide to conduct a market segmentation analysis..

7. Covid-19 Trends- Power BI

   Use Case: During the COVID-19 pandemic, public health authorities and policymakers need accurate and timely information to respond effectively to the evolving situation. Market segmentation analysis can be a valuable tool to understand how different

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population segments are affected by the virus, which can inform targeted interventions and resource allocation.

8. Exploring COVID-19 Data Trends

   Use Case: Health authorities want to visualize and analyze trends in COVID-19 cases to inform public health policies.
   Experiment: Collect COVID-19 data from reliable sources such as government health departments. Use data visualization tools to create interactive dashboards displaying trends in case counts, testing rates, and vaccination coverage. Analyze the data to identify hotspots and patterns over time.

9. Visualizing Stock Market Volatility

   Use Case: Financial analysts want to visualize and analyze stock market volatility to make informed investment decisions.
   Experiment: Gather historical stock market data from financial databases. Use data visualization techniques to create candlestick charts and volatility plots showing price fluctuations and trading volumes. Apply technical analysis indicators such as moving averages and Bollinger Bands to identify potential trading opportunities.

10. Sales Performance Analysis

   Use Case: Analyze sales data to identify top-performing products and regions for strategic decision-making.
   Experiment: Analyze sales data using Microsoft Excel to uncover insights into sales performance and trends. Utilize Excel's data manipulation, visualization, and analysis tools to examine total sales revenue, product performance, regional sales distribution, and sales trends over time.

Text Books:

1. Avrim Blum, John Hop croft, and Ravindran Kannan," Foundations of Data Science", Springer-2018
2. Suresh Kumar Mukhiya, Usman Ahmed, "Hands-On Exploratory Data Analysis with Python", O'Reilly, 2013.
3. Cathy O' Neil, Rachel Schutt, "Doing Data Science, Straight Talk from The Frontline", O'Reilly, 2013.
4. Chandraish Sinha, "Tableau 10 for Beginners: Step by Step Guide to Developing Visualizations in Tableau 10", Create space Independent Pub, 2017.

References:

Reference Books:

1. Dean J, "Big Data, Data Mining and Machine learning", Wiley Publications, 2014.
2. Provost F and Fawcett T, "Data Science for Business" ,O'Reilly Media Inc, 2013.

Journals References:

1. https://jds-online.org/journal/JDS
2. https://link.springer.com/journal/41060
3. https://epjdatascience.springeropen.com/

Video References:

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1. https://www.youtube.com/watch?v=-ETQ97mXXF0 2. https://www.youtube.com/watch?v=dcXqhMqhZUo&t=2s
MOOC/NPTEL/SWAYAM Courses: 1. https://onlinecourses.nptel.ac.in/noc21_cs69/preview 2. https://onlinecourses.nptel.ac.in/noc22_cs32/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AD651.1	Apply the fundamentals of data science for effective contribution to real-world.
R19AD651.2	Apply the various data collection and exploration techniques to analyze the data
R19AD651.3	Design interactive dashboards using suitable data science tools to reveal the insights of data.
R19AD651.4	Analyze the distribution of data using various statistical techniques.
R19AD651.5	Analyze datasets using Python packages and Microsoft Excel to derive actionable.

R19AD652	**Exploratory Data Analysis and Visualization**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

1. Course Description:

This course covers principles and tools for creating impactful visualizations, using software like Tableau, Power BI, and Python libraries. Students learn to analyze and communicate data effectively, developing interactive dashboards and compelling visual narratives for decision-making across industries.

2. Course Objectives:

1. To learn the essential exploratory techniques for analyzing and visualizing data.
2. To gain hands-on experience of using software tools for data preparation, analytics, and visualization.
3. To utilize visualization for exploratory data analysis, identifying patterns and trends.
4. To apply visualization techniques to practical, real-world datasets.
5. To develop compelling visual narratives to communicate insights effectively.

3. Syllabus:

Unit-I: Data Exploration

Data: Aesthetics, Types of Data, Coordinate systems and axes, Colour Scales; Data Cleanup Basics: Normalizing and standardizing the data; Exploring the data: Importing the data, exploring table, functions, identifying correlation and outliers; Introduction to Single variable: Distribution Variables, Numerical Summaries of Level and Spread, Scaling and Standardizing, Inequality, Smoothing Time Series.

Unit-II: Data Analysis

Data collection and management: Introduction, Sources of data, Data collection, APIs; Data Pre- processing Techniques; Data Analysis and Data Analytics: Descriptive Analysis, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics, Exploratory Analysis, Mechanistic Analysis; Analysis Method: Quantitative Methods, Qualitative Methods; Evaluation: Comparing Models, Cross Validation; Data storage and management, using multiple data sources.

Unit-III: Data Visualization

Seven Stages of Visualizing Data, Univariate Plots: Histogram, Single and multiple distributions, Probability Distribution plots, Run Sequence Plots; Bivariate Plots: Bar graphs, Heat maps; Density Plots, Pair plots, Contour plots; Empirical cumulative distribution functions and q-q plots; Time series Data: Individual time series, Multiple time series and dose–response curves; Geo-spatial Data: Cartograms.

Unit-IV: Introduction to Tableau

Overview of Tableau and its applications, Installation and setup, connecting to data sources (Excel, CSV, databases), Understanding Tableau's interface; Data Preparation in Tableau, Maps and geographical data visualization, Intermediate Visualization Techniques, Storytelling with Tableau, Real-time data connections and live dashboards.

Unit-V: Power BI for Data Visualization and Analysis

Data Preparation and Transformation, Basic Visualization Techniques, Advanced DAX functions and calculations, Power BI Data Modelling; Case Study: Wildfire Activity in the Western United States, Single Family Residential Home and Rental Values.

List of Experiments:

1.	You are a data analyst working for an insurance company and you have been tasked with generating a comprehensive data quality report for the company's customer data. The data is intended to be used for risk assessment and policy pricing. The dataset contains information about policyholders, their coverage details, and claim history. Your goal is to identify and report on missing values, irregular cardinality, and outliers in the dataset.
2.	You are a data analyst working for a winery, and your team has provided you with a dataset containing information about various attributes related to wine quality. The dataset includes features such as acidity levels, residual sugar, alcohol content, and the quality rating assigned by experts. Your task is to perform Exploratory Data Analysis (EDA) to gain insights into the characteristics of the wines and understand the factors influencing wine quality.
3.	You are a data scientist working for an e-commerce company, and your team has provided you with a dataset containing information about customer purchases. The dataset includes features such as purchase amount, product category, customer age, and the time of purchase. Your goal is to prepare the data for exploratory analysis, employing normalization, binning, and sampling methods.
4.	You are a data scientist working for a telecommunications company, and your team is interested in predicting customer churn. The dataset includes various features such as customer tenure, monthly charges, usage patterns, and customer satisfaction scores. Your task is to identify a descriptive feature that shows a clear relationship with the target feature, which is whether a customer churns or not. You will use visualization techniques to explore these relationships effectively.

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5.	You are a data scientist working for a retail company, and your team has provided you with a time series dataset containing daily sales data for various products over the past few years. Your task is to perform time series analysis to understand sales patterns, trends, and seasonality. Additionally, you need to forecast future sales using appropriate visualization techniques.
6.	You work for a travel and tourism company, and your team has tasked you with analyzing and visualizing data related to popular tourist destinations. The dataset includes information such as location coordinates, tourist attractions, and ratings. Your goal is to perform data analysis and represent the information on a map with interactive features, including mouse rollover effects and user interaction.
7.	You work for a global non-profit organization that focuses on socio-economic development, and your team has tasked you with creating cartographic visualizations for multiple datasets involving various countries worldwide and specific states and districts within India. The datasets cover diverse indicators such as education, health, and economic factors. Your goal is to create insightful visualizations that allow stakeholders to compare socio-economic conditions across different regions.
8.	Assume you have a sample COVID-19 dataset named covid_data with variables like Date, Country, Confirmed_Cases, Deaths, and Recovered. How can you filter rows and variables in Tableau? Use the ggplot2 package for data visualization to understand the trend of confirmed cases, deaths, and recoveries over time. Consider a real- time problem: "Visualizing the spike in confirmed cases for a specific country, e.g., USA."
9.	**Case Study 1: Retail Sales Analysis** Objective: You are a data analyst for a retail company, and the management wants you to analyze the sales data to identify trends, customer preferences, and potential areas for improvement. Dataset: The dataset includes the following columns: Order_ID: Unique identifier for each order. Order_Date: Date of the order placement. Product_ID: Unique identifier for each product. Product_Name: Name of the product. Category: Product category (e.g., Electronics, Clothing, Home Appliances). Unit_Price: Price of one unit of the product. Quantity: Number of units ordered. Total_Sales: Total sales amount for the order. Insights and Recommendations: a. Monthly Sales Trend: Sales have been consistently increasing, with a noticeable spike in [specific month]. Management could investigate the factors contributing to this increase for potential replication in other months. b. Product Category Analysis: [Category A] is the highest-selling category, indicating a strong demand. The company might consider expanding or promoting products within this category. c. Top Selling Products: [Top Product 1] and [Top Product 2] are the highest-selling products. Marketing efforts can be focused on these products to capitalize on their popularity. d. Customer Segmentation: Further analysis is needed to understand customer segments based on demographics. Targeted marketing strategies can be developed for each segment. e. Correlation Analysis: Positive correlations between [Variable X] and [Variable Y] suggest that changes in [Variable X] may impact [Variable Y]. Further investigation is recommended.

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	Case Study 2: Ridesharing Platform Analysis Objective: You are a data analyst for a ridesharing company, and the management wants you to analyze the rides data to gain insights into user behavior, trip patterns, and areas for service improvement. Dataset: The dataset includes the following columns: Ride_ID: Unique identifier for each ride. User_ID: Unique identifier for each user. Timestamp: Date and time of the ride. Pickup_Location: Pickup location of the ride. Dropoff_Location: Dropoff location of the ride. Distance: Distance of the ride in miles. Duration: Duration of the ride in minutes. Fare: Fare amount for the ride. Rider_Rating: Rating given by the rider to the driver (out of 5). Insights and Recommendations: a. User Activity Over Time: There is a noticeable increase in rides during peak hours, suggesting high demand during specific times. Consider adjusting service capacity or introducing dynamic pricing during peak hours. b. Trip Duration Distribution: Most trips have a duration of between 10-30 minutes. Investigate and optimize routes for shorter trips to enhance efficiency. c. User Ratings Analysis: The median rider rating is high, indicating overall satisfaction. Identify factors contributing to low ratings and address them to maintain service quality. d. Geographical Analysis: Analyze popular pickup and dropoff locations to optimize driver allocation and potentially identify areas for promotional campaigns. Further Analysis: a. User Segmentation: Explore user segments based on frequency, distance traveled, and rider ratings. Tailor marketing strategies for each segment. b. Price Sensitivity Analysis: Investigate the relationship between fare amounts and rider ratings. Understand if there is a correlation and adjust pricing strategies accordingly. c. Weather Impact: If available, incorporate weather data to analyze how weather conditions influence ride demand and duration.
10.	**Mini project:** **Scenario 1: E-commerce Sales Analysis** Objective: You are working for an e-commerce company, and the management wants to understand the sales performance of their products over the past year. They have provided you with a dataset containing information about the sales transactions. Dataset: The dataset includes the following columns: Transaction_ID: Unique identifier for each transaction. Product_ID: Unique identifier for each product. Product_Name: Name of the product. Transaction_Date: Date of the transaction. Transaction_Amount: The amount of money spent on the transaction. Perform the following tasks and subtasks: 1. Data Exploration a. Load the data

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	b. Explore the data c. Check for missing values 2. Data Visualization a. Time series analysis b. Product sales distribution c. Transaction amount distribution d. Monthly sales trend **Scenario 2: Fitness App User Engagement Analysis** Objective: You are working for a fitness app company, and the management wants to understand the user engagement patterns and activity levels of their users. They have provided you with a dataset containing information about user activities. Dataset: The dataset includes the following columns: User_ID: Unique identifier for each user. Date: Date of the activity. Steps: Number of steps taken by the user on that day. Calories Burned: Calories burned by the user on that day. Active Minutes: The total number of active minutes (e.g., exercise, workout) by the user. Perform the following tasks and subtasks: 1. Data Exploration a. Load the data b. Explore the data c. Check for missing values 2. Data Visualization a. Daily Steps Trend b. Calories Burned vs. Active Minutes c. Weekly Aggregation of Steps d. Histogram of Active Minutes e. User Engagement by Day of the Week

Text Books:

1. Claus O Wilke, "Fundamentals of Data Visualization A Primer on Making Informative and Compelling Figures", O'Reilly Media, Inc., First Edition, 2019.
2. David Baldwin," Mastering Tableau: Smart Business Intelligence techniques to get maximum insights from your data", Packt, First Edition, 2016.

References:

Reference Books:

1. Catherine Marsh, Jane Elliott, Exploring Data: An Introduction to Data Analysis for Social Scientists, Wiley Publications, 2nd Edition, 2008.
2. Alberto Cairo, "The Functional Art: An Introduction to Information Graphics and Visualization", New Riders, 2012.
3. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics", John Wiley & Sons, 3rd Edition, 2011.
4. Ben Fry, "Visualizing Data", O" Reilly Media, Inc., 2007.

Journals References:

1. Deepmala Srivastava, "An Introduction to Data Visualization Tools and Techniques in Various Domains," International Journal of Computer Trends and Technology, vol. 71, no. 4, pp. 125-130, 2023. Crossref, https://doi.org/10.14445/22312803/IJCTT-V71I4P116
2. Diamond, Michael and Angela Mattia. "Data Visualization: An Exploratory Study into the Software Tools Used by Businesses." Journal of Instructional Pedagogies 17 (2015).

Video References:

1. https://www.youtube.com/watch?v=TPMlZxRRaBQ
2. https://youtu.be/64-eK-tdTPc

MOOC/NPTEL/SWAYAM Courses:

1. https://www.udemy.com/course/data-exploration-data-analysis-data-visualization/
2. https://www.coursera.org/courses?query=data%20visualization

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AD652.1	Apply the key techniques and theory behind Data Exploration.
R19AD652.2	Apply the statistical techniques and methods for Data visualization
R19AD652.3	Apply various data visualization techniques for a variety of tasks
R19AD652.4	Implement data visualization techniques using Tableau and Power BI
R19AD652.5	Create story telling Dashboards using Tableau and Power BI

R19AD653	**Machine Learning Techniques**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course provides an in-depth introduction to the fundamental concepts and techniques of machine learning, a field at the intersection of computer science and statistics that focuses on the development of algorithms capable of learning from data. Students will gain a comprehensive understanding of the principles and applications of machine learning, along with hands-on experience in implementing and evaluating machine learning models.

2. Course Objectives:

1. To explain the different types of Machine learning techniques and mathematical concepts
2. To use natural language processing techniques using large language models
3. To apply the different machine learning tools to solve the real-time problems

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4. To make decisions using reinforcement learning and Markov Decision process.

3. Syllabus:

Unit-I: Introduction

Review of Linear Algebra for Machine Learning. Introduction and motivation for machine learning; Types of Machine Learning: Supervised Learning, Unsupervised Learning and Reinforcement learning.Statistical Decision theory: Classification and Regression, Bias and Variance.

Case Study: Stock Price Prediction

Unit-II: Classification and Regression

Linear Regression, Multivariate Regression, Subset Selection, Shrinkage methods, Principal Components Regression, Partial Least Squares. Ridge and LASSO Regression. Logistic Regression. Linear Discriminant Analysis. Decision Tree, K Nearest Neighbor, Separating hyperplane – Perceptronlearning Support Vector Machines and kernels. Artificial Neural Networks: Backpropagation Algorithm, Maximum Likelihood estimate.

Case Study: House Price Prediction using Linear Regression and spam email classification usingsupport vector machine algorithm.

Unit-III: Evaluation Measures and Ensemble Techniques

Evaluation Measures: Bootstrapping and cross validation ROC Curve, Minimum Description length and exploratory analysis. Ensemble Methods: Bagging, Committee machines, Stacking, Boosting, Gradient Boosting, Random Forest

Case Study: Random Forest for Credit Scoring and Stacking for Image Classification

Unit-IV: Bayesian Networks and Clustering

Naïve Bayes, Bayesian Networks, Undirected Graphical models, Hidden Markov models, Variable Elimination, Belief Propagation; Partitional Clustering, Hierarchical Clustering, BIRCH and CURE algorithms, Density based Clustering, Spectral Clustering.

Case Study: Analyze customer reviews to determine the sentiment (positive, negative, or neutral) associated with a product or service.

Unit-V: Reinforcement Learning

Introduction to Reinforcement Learning, Framework, Elements of Reinforcement learning, MarkovDecision Process, Q – Learning in Python, Deep Q- learning.

Case Study: Game Playing

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, Prentice Hall of India, 2015.
2. Tom Mitchell, "Machine Learning", McGraw-Hill, 2017.
3. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

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4. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
5. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, CRC Press,2014.

References:

Reference Books:

1. Fabio Nelli, "Python Data Analytics with Pandas, Numpy, and Matplotlib", Second Edition, Apress,2018. Educational Publishers Inc., 2015.
2. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", FirstEdition, Cambridge University Press, 2012.

Video References:

1. https://www.youtube.com/c/3blue1brown
2. https://www.youtube.com/channel/UCfzlCWGWYyIQ0aLC5w48gBQ

Web Resources:

1. https://www.youtube.com/channel/UCWN3xxRkmTPmbKwht9FuE5A
2. Machine Learning by Andrew Ng on Coursera

MOOC/SWAYAM/NPTEL Courses:

1. Introduction to Deep Learning - MIT Open Courseware
2. Essential Mathematics for Artificial Intelligence on edX

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AD653.1	Apply the mathematical concepts of Machinelearning to solve real-time problems.
R19AD653.2	Apply the different types of Machine learningand graphical modelling for data analysis andvisualization.
R19AD653.3	Implement boosting algorithms using appropriate libraries and tune hyperparametersfor optimal performance.
R19AD653.4	Interpret and communicate the results obtained from Bayesian network analysis and clusteringalgorithms in the context of specific applications.
R19AD653.5	Examine the Markov Decision Process and Reinforcement learning algorithms in a simulated environment

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R19AD654	Foundations of Artificial Intelligence	L	T	P	C
		3	0	0	3

1. Course Description:

This course offers a comprehensive exploration of the foundational principles and core concepts in Artificial Intelligence (AI). Beginning with an introduction to the history and applications of AI, the course progressively delves into intelligent agents, problem-solving, search algorithms, and extends to encompass knowledge representation and planning. Through a structured journey, students will delve into the origin of Artificial Intelligence (AI), covering a spectrum of topics crucial for understanding and equipping them with the problem-solving skills essential for the broader field of AI.

2. Course Objectives:

1. To study about structure of agents and the nature of environments
2. To learn the search algorithms of AI in different environments
3. To Learn and apply adversarial search techniques to solve problems in dynamic environments.
4. To study and infer the logical and probabilistic inference mechanisms.
5. To study the knowledge representation and planning algorithms.

3. Syllabus:

Unit-I: Intelligent Agents

Introduction to artificial intelligence; Intelligent agents: agents & environment, concept of rationality, nature of environments, structure of agents.
Case Study: Autonomous Delivery Robots which interact with their surroundings and navigate through dynamic environments to deliver packages.

Unit-II: Problem Solving Agents

Uninformed search strategies, Heuristic search strategies, heuristic functions; Local search and optimization problems, local search in continuous space, search with nondeterministic actions, search in partially observable environments, online search agents and unknown environments.
Case Study: Autonomous vehicle Navigation in Unknown Environments

Unit-III: Game Playing and CSP

Adversarial search: Games, optimal decisions in games, alpha - beta pruning, stochastic games, partially observable games; Constraint satisfaction problems; constraint propagation, backtracking search for CSP, local search for CSP, structure of CSP
Case Study: Artificial intelligence system plays chess to make optimal moves in a partially observable and dynamic environment.

Unit-IV: Logical Agents

Knowledge-based agents, propositional logic, propositional theorem proving, propositional model checking, agents based on propositional logic; First-order logic: syntax and semantics, knowledge representation and engineering; Inferences in first-order logic: forward chaining, backward chaining, resolution
Case Study: Automated personal assistant to assist users in managing their daily tasks, scheduling, and information retrieval.

Unit-V: Knowledge Representation and Planning

Ontological engineering, categories and objects, events, mental objects and modal logic, reasoning systems for categories, reasoning with default information; Classical planning,

algorithms for classical planning; time, schedule, and resources analysis, hierarchical planning, planning and acting in non-deterministic domains
Case Study: Autonomous Warehouse Management System (WMS) for efficient planning, scheduling, and resource allocation within a warehouse environment.

Text Books:

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition, Pearson Education, 2020.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill Publishing Company, New Delhi, 2014.

References:

Reference Books:

1. I. Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison-Wesley Educational Publishers Inc., 2015.
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, New Delhi, 2017

Video References:

1. https://www.youtube.com/watch?v=R3nqhDIEyMg&list=PLaatXkJEXKyJjYYOrWrmVPNbWvs_sRgm
2. https://www.youtube.com/watch?v=WfdwKUuiLNo&list=PLbhdEzRraaeGjIhuP96wB3L2BTBhaOeWe

Web References:

1. https://www.geeksforgeeks.org/optimal-decision-making-in-games/
2. https://www.javatpoint.com/ai-informed-search-algorithms

MOOC/SWAYAM/NPTEL Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs81/preview
2. https://www.udemy.com/course/searching-algorithms-in-ai/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AD654.1	Implement a study of agents' structures and diverse environments in AI.
R19AD654.2	Apply various AI search algorithms for different environmental scenarios using the knowledge and skills acquired.
R19AD654.3	Implement a comprehensive study of adversarial search techniques and resolving constraint satisfaction problems in AI.
R19AD654.4	Apply logical and probabilistic inference mechanisms to improve decision-making in AI systems.
R19AD654.5	Analyse knowledge representation techniques and planning algorithms vital for Artificial Intelligence

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R19CC651	Network Protocols	L	T	P	C
		2	0	2	3

1. Course Description:

This course is designed to equip students with a solid understanding of network protocols, addressing, and their functions in computer networks. Topics covered include the various types of IP addressing, the functionalities of Internet Protocol (IP), and the basics of TCP protocol design and operations. Additionally, students will learn to identify different types of TCP/IP family network protocols crucial for effective network management and communication.

2. Course Objectives:

1. To examine network protocols, addressing, and functions for foundational comprehension.
2. To make students understand diverse IP addressing types for efficient network management.
3. To summarize Internet Protocol functionalities for communication understanding.
4. To gain knowledge of TCP protocol basics for reliable data transmission comprehension.
5. To identify TCP/IP family protocols for specific network functionality comprehension.

3. Syllabus:

Unit-I: Protocols and Standards

Protocols and Standards- Internet Standards-Protocol Layers-OSI Reference Model-TCP/IP Protocol Suite-Addressing: Physical, Logical, Application and Port Addressing.

Unit-II: IP Addressing

Address Space- Notation- Range of Addresses-Classful Addressing: Classes And Blocks-Two-Level Addressing- Subnetting and Supernetting-Classless Addressing: Variable-Length Blocks- Two-Level Addressing- Block Allocation.

Unit-III: Internet Protocol

TCP/IP Protocol Suite -Datagram-Fragmentation-Options- Checksum-Security: Packet Sniffing, Packet Modification, IP Spoofing-IP Packaging-Internet Control Message Protocol: Messages and Formats- Error Reporting-Query- Checksum- Internet Control Message Protocol Design

Unit-IV: Transmission Control Protocol

Process To Process Communication -TCP Services –Segment -Options- Checksum-Flow Control- Error Control- TCP Timers-Connection-State Transition Diagram-Congestion Control-TCP Operation- TCP Design

Unit-V: TCP/IP Family Protocols

User Datagram Protocol: UDP Services-UDP Applications-File Transfer Protocol: Connections Communication-Command Processing-File Transfer-Anonymous FTP-Security For FTP- Hypertext Transfer Protocol: HTTP Overview-Message Formats- HTTP Connections-Security

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List of Experiments:

1. Simulate and compare the OSI and TCP/IP protocol layers using a network simulator
2. Configure a small network using Classful and Classless (CIDR) IP addressing schemes. Perform subnetting and supernetting to manage IP addresses efficiently in Cisco Packet Tracer.
3. Analyze IP packets, focusing on packet fragmentation, reassembly, and identifying spoofed packets.
4. Simulate a TCP connection establishment and analyse its flow control mechanism
5. Set up an FTP server and client, transfer files between them, and monitor the communication

Text Books:

1. Behrouz A. Forouzan, —TCP/IP Protocol Suite‖, Tata McGraw Hill Publishing Company, New Delhi, 2010.
2. DOUGLAS E. COMER, —Internetworking With TCPI/IP Principles, Protocols, and Architecture‖, Pearson, 2015.

References:

1. Achyut S. Godbole, Atul Kahate —Data Communications and Networks, Tata McGraw Hill Publishing Company, New Delhi, 2011.
2. William Stallings —Data and Computer Communications‖, Pearson Prentice-Hall, New Delhi, 2011.
3. W. Richard Stevens, —TCP/IP Illustrated: The Protocols‖, Addison-Wesley Professional, 2011.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CC651.1	Implement the basics of protocols, addressing, and their functions in computer networks.
R19CC651.2	Classify the different types of IP addressing and their functions in networks.
R19CC651.3	Demonstrate the functionalities of Internet Protocol and its elements.
R19CC651.4	Analyze the basics of TCP protocol design and operations.
R19CC651.5	Differentiate the types of TCP/IP family of network protocols within the network.

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R19CC601	High Speed Networks	L	T	P	C
		3	0	0	3

1. Course Description:

This course is designed to provide a comprehensive understanding of high-speed networks, focusing on the architecture of ATM and high-speed LANs. Students will analyze congestion control within packet-switching networks, describe various traffic management techniques in ATM, and explore the basic taxonomy and architecture implementation of high-speed wireless LANs. Additionally, they will learn to compare and select appropriate modes in wireless ATM networks, preparing them for effective network design and management in high-speed environments.

2. Course Objectives:

1. To examine ATM and high-speed LAN architectures for foundational comprehension.
2. To make students understand congestion control in packet-switching networks for effective management.
3. To impart knowledge on traffic management techniques in ATM to optimize performance.
4. To examine high-speed wireless LAN taxonomy and architecture for comprehension.
5. To compare and select modes in wireless ATM networks for efficient transmission.

3. Syllabus:

Unit-I: High Speed Networks

Asynchronous Transfer Mode – ATM Protocol Architecture, ATM Logical Connection – ATM Cell – ATM Service Categories – AAL. High Speed LANs – Fast Ethernet – Gigabit Ethernet – Fibre Channel – Wireless LAN's Applications, Requirements – Architecture of IEEE 802.11.

Unit-II: Queuing Analysis and Congestion Control

Single Server Queues – Multiserver Queues – Queues with Priorities – Networks of Queues –Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control

Unit-III: ATM Congestion Control

Traffic and Congestion Control in ATM – Requirements – Attributes – Traffic Management Frame Work – Traffic Control – ABR Traffic Management – ABR Rate Control – RM Cell Formats – ABR Capacity Allocations – GFR Traffic Management.

Unit-IV: High Speed Wireless Lan

Classification Of Wireless LANs: Radio LANs-Direct Sequence Spread Spectrum-Frequency Hopping Spread Spectrum-Comparison-Infrared LANs-Wireless LAN Implementation-Components-Protocol Architecture-LAN Topologies-Deployment-Performance of Wireless LANs.

Unit-V: Wireless ATM Networks

ATM Technology: Comparison of Transfer Modes, ATM vs IP- Need for Wireless ATM-Wireless Communication using ATM-Multimedia Communications using Wireless ATM.

Text Books:

1. William Stallings, —High-speed Networks and Internet, Pearson Education

Edition, 2002. 2. Benny Bing, —High-Speed Wireless ATM and LANs, Artech House Publishers, 2000
References:
1. Jean Warland, Pravin Varaiya—High-performance Communication Networks‖, Jean Harcourt Asia Private Limited, 2nd Edition, 2000. 2. Abhijit S. Pandya, ErcanSen —ATM Technology for Broadband Telecommunications Networks, CRC Press, 2004. 3. William Stallings —High-speed Networks: TCP/IP and ATM Design Principles‖, PHI, 2nd Edition, 2008

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CC601.1	Implement the basics of architecture of ATM and high-speed LANs.
R19CC601.2	Analyze and manage congestion control in various scenarios within packet switching networks.
R19CC601.3	Demonstrate a range of traffic management strategies in ATM.
R19CC601.4	Evaluate the basic taxonomy in high-speed wireless LANs and their architectural implementation.
R19CC601.5	Select and apply appropriate modes in wireless ATM networks.

R19CC602	**Introduction to Industrial Networking**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course is designed to provide an introduction to industrial networking, covering fundamental concepts such as data networks and internetworking. Students will familiarize themselves with serial communications, delve into specifics like HART and Field buses, and understand communication protocols like MODBUS and PROFIBUS. Additionally, the course explores industrial Ethernet and wireless communication, equipping students with essential knowledge for navigating the complexities of industrial networking.

2. Course Objectives:

1. To examine data network basics to establish foundational understanding.
2. To understand internetworking and serial communications fundamentals for application.
3. To explore HART and Field buses to grasp their industrial significance.
4. To make students understand MODBUS, PROFIBUS, and other protocols for effective communication.
5. To impart knowledge on industrial Ethernet and wireless communication for modern networking.

3. Syllabus:

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Unit-I: Data Network Fundamentals
Networks hierarchy and switching – Open System Interconnection model of ISO - Data link control protocol - Media access protocol - Command/response - Token passing - CSMA/CD, TCP/IP
Unit-II: Internet Working and RS 232, RS 485
Bridges - Routers - Gateways - Standard ETHERNET and ARCNET configuration special requirement for networks used for control - RS 232, RS 485 configuration Actuator Sensor (AS) – interface, Device net.
Unit-III: HART and Fieldbus
Introduction - Evolution of signal standard - HART communication protocol - HART networks – HART commands - HART applications - Field bus - Introduction - General Field bus architecture – Basic requirements of Field bus standard - Field bus topology - Interoperability - Interchangeability - Introduction to OLE for process control (OPC).
Unit-IV: Modbus and Profibus PA/DP/FMS and FF
MODBUS protocol structure - function codes – troubleshooting Profibus, Introduction, Profibus protocol stack, Profibus communication model - communication objects - system operation - troubleshooting - review of foundation field bus - Data Highway
Unit-V: Industrial Ethernet and Wireless Communication
Industrial Ethernet, Introduction, 10 Mbps Ethernet, 100 Mbps Ethernet - Radio and wireless communication, Introduction, components of radio link - radio spectrum and frequency allocation – radio MODEMs-Introduction to wireless HART and ISA100.
Text Books:
1. Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, Practical Industrial Data Networks 2. 'Design, Installation and Troubleshooting' Newnes Publication, Elsevier First Edition, 2004 3. A. Behrouz Forouzan, Data Communications & Networking,3RD edition, Tata Mc Graw hill, 2006.
References:
1. Andrew S. Tanenbaum, David J. Wetherall, Computer Networks, Prentice Hall of India Pvt. Ltd., 5th Edition. 2011. 2. Theodore S Rappaport, Wireless Communication: Principles and Practice, Prentice Hall of India 2nd Edition, 2001. 3. William Stallings, Wireless Communication & Networks, Prentice Hall of India, 2nd Edition, 2005.

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4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CC602.1	Apply the basic concepts of data networks.
R19CC602.2	Implement the basics of internetworking and serial communications.
R19CC602.3	Utilize the details of HART and Field buses.
R19CC602.4	Implement MODBUS, PROFIBUS, and other communication protocols.
R19CC602.5	Apply industrial Ethernet and wireless communication concepts.

R19CC603	**Basics of Mobile Communication**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

This course is designed to provide a comprehensive understanding of the basics of mobile communication. Students will explore wireless communication mediums used in cellular systems, understand the architecture and fundamentals of mobile telecommunication systems, and delve into the architecture of Wireless LAN technologies. Additionally, they will determine the functionalities of network and transport layers, illustrate the generations of wireless networks, and acquire knowledge of application layer functionalities and associated languages and operating systems in mobile communication.

2. Course Objectives:

1. To impart knowledge on wireless communication mediums for cellular systems, establishing a foundational understanding.
2. To equip students with a practical understanding of mobile telecommunication system architecture.
3. To provide comprehensive insights into the architecture of Wireless LAN technologies.
4. To enhance the understanding of network and transport layer functionalities, along with the evolution of wireless network generations.
5. To develop expertise in application layer functionalities, associated programming languages, and operating systems relevant to mobile communications.

3. Syllabus:

Unit-I: Wireless Transmission and Channel

Introduction: Applications, History of wireless communication. Wireless Transmission: Frequencies for radio transmission, Signal Propagation, Cellular Systems. Medium Access Control: Motivation for a specialized MAC, SDMA, FDMA, TDMA and CDMA.

Unit-II: Mobile Communication Systems

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Mobile Communication systems: GSM Mobile services, System Architecture, Radio Interface, Protocols, Localization and calling, Handover, Security, New Data services. Satellite systems: Overview and applications. Broadcast systems: Overview, DAB and DVB, Convergence of Broadcasting and Mobile communication
Unit-III: Wireless LAN
Wireless LAN: Infra-red vs. radio transmission, Infrastructure and ad-hoc network, IEEE 802.11, HIPERLAN, Bluetooth
Unit-IV: Mobile Network Layer and Transport Layer
Mobile Network Layer and Transport Layer: Mobile IP, Dynamic Host Configuration Protocol, Mobile adhoc networks, Traditional and classical TCP and TCP over 2.5/3G wireless networks.
Unit-V: Application Layer
Application Layer: Wireless Application Protocol, Architecture, Wireless datagram protocol, wireless transport layer security, wireless transaction protocol, wireless session protocol, wireless application environment, wireless mark-up language, WMLScript, I-mode, SuncML, WAP2.0, Mobile Application Languages: Mobile application Development, XML, JAVA, Java 2 Micro Edition, Java card, Mobile Operating system: Window Mobile and CE, Android.
Text Books:
1. Jochen Schiller, —Mobile communications‖ Pearson, 2nd edition 2009 2. Clint Smith, Daniel Collins, —Wireless Networks, Third Edition, McGraw Hill Publications, 2014.
References:
1. Raj Kamal, —Mobile Computing Oxford University Press 2nd Edition 2. Prasanth Kumar Patnaik, Rajib Mall, — Fundamentals of Mobile Computing‖, PHI Learning Pvt. Ltd., New Delhi, 2012

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CC603.1	Apply the concepts of wireless communication and mediums used for cellular systems.
R19CC603.2	Implement the basics of mobile telecommunication systems and their architectures.
R19CC603.3	Utilize the architecture of Wireless LAN technologies.
R19CC603.4	Determine the functionality of the network layer and transport layer, and illustrate the generations of wireless networks.
R19CC603.5	Apply the functionalities of application layer and associated languages and operating systems in mobile communications.

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R19CC604	Introduction to Wireless Communication Networks	L	T	P	C
		3	0	0	3

1. Course Description:

This course is designed to provide an introduction to wireless communication networks, covering fundamental concepts and technologies. Students will understand the basics of wireless communication systems, explore cellular system concepts based on resource availability, and analyze the performance of various modulation schemes. Additionally, they will delve into the concepts of multiple input multiple output (MIMO) systems and grasp basic wireless networking concepts, preparing them for navigating the complexities of wireless communication networks.

2. Course Objectives:

1. To impart knowledge on wireless communication systems for foundational understanding.
2. To develop an understanding of cellular system concepts with a focus on resource availability.
3. To explore and analyze the performance of various modulation schemes.
4. To provide insights into the concepts of different MIMO systems for deeper comprehension.
5. To foster a comprehensive understanding of basic wireless networking concepts.

3. Syllabus:

Unit-I: Services and Technical Challenges

Types of Services, Requirements for the services and Technical Challenges of wireless communication-Multipath propagation, Spectrum Limitations, Noise and Interference

Unit-II: Cellular Communication Concepts

Introduction - frequency reuse - channel assignment - handoff - coverage and capacity improvement, Multiple Access techniques – TDMA, FDMA, CDMA, SDMA.

Unit-III: Wireless Transceivers

Structure of a wireless communication link, Modulation and demodulation – Quadrature Phase Shift Keying, pi/4-Differential Quadrature Phase Shift Keying, Offset-Quadrature Phase Shift Keying, Binary Frequency Shift Keying, Minimum Shift Keying, Gaussian Minimum Shift Keying, OFDM Principles.

Unit-IV: Multipath Mitigation and MIMO Systems

Equalization – Adaptive equalization, Linear and Non-Linear equalization. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver. MIMO systems – spatial multiplexing -System model -Pre-coding – Beamforming.

Unit-V: Wireless Networks

Introduction-IEEE 802.11 project – Bluetooth – WiMAX- IEEE project 802.16 – Cellular Telephony –
Generations, satellite communication Networks- GEO satellite, MEO Satellites, LEO Satellites.

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Text Book:
1. Andreas.F. Molisch, —Wireless Communications‖, John Wiley – India, 2nd Edition.
Reference Books:
1. Rappaport,T.S., —Wireless communications‖, Second Edition, Pearson Education, 2010. 2. Behrouz A. Forouzan —Data communication and Networking‖, Fourth Edition, Tata McGraw – Hill, 2011. 3. Simon Haykin & Michael Moher—Modern Wireless Communications‖, Pearson Education, 2007. 4. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CC604.1	Demonstrate an understanding of the basics of wireless communication systems.
R19CC604.2	Analyze cellular system concepts based on resource availability.
R19CC604.3	Evaluate the performance of various modulation schemes.
R19CC604.4	Apply the concepts of various MIMO systems.
R19CC604.5	Apply basic wireless networking concepts.

R19CB601	Algorithmic Trading Strategies	L	T	P	C
		3	0	0	3

1. Course Description:

The aim of the Algorithmic Trading Strategies course is to investigate various methods implemented in trading strategies with emphasis on automated trading. The course also provides a broad view of the algorithmic trading strategies, system architecture, and its risk management. The course content includes methods implemented in multiple quantitative trading strategies on quantitative finance-based approaches to enhance the trade decision making mechanism. Students will learn to quantify liquidity risk, market risk, operational and real economy risks; as well as how to manage those risks.

2. Course Objectives:

1. To understand some basic theories of quantitative trading.
2. To implement spectrum of modelling skills to investigate and summarize stylized features of the market data.
3. To acquire skills in designing and implementing systematic investment trading strategies.

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4. To learn regulations and risk management aspects of the business of quantitative trading.
5. Gain a comprehensive understanding of the importance of audit and compliance processes.

3. Syllabus:

Unit-I: Introduction to Algorithmic Trading

Overview: Evolution of Algorithmic Trading, Meaning of Algorithmic Trading, Different Trading Methodologies; Trends in Algorithmic Trading: Global and India, Benefits of Algorithmic Trading.

Unit-II: Trading Strategies

Order Types: Different Order Types, Execution of Trading Strategies; Trading Strategies: Calendar Spread, Cash Future Arbitrage Strategy, Index Arbitrage, Pair Trading, News Based Trading Strategies, Conversion, Reversal.

Unit-III: Algorithmic Trading: System Architecture

Market Data: CEP Engine, Order Routing / Order Manager, Colocation, Smart Order Routing (SOR), Connectivity Options.

Unit-IV: Risk management in Algorithmic Trading

Different Stages involved in Risk Management, Risk Management Specific to High Frequency & Algorithmic Trading.

Unit-V: Audit and Compliance Process

International Organization of Securities Commissions, Auditing Process and Requirements (As defined by NSE for member-broker); SEBI Recommendations on Algorithmic Trading: Software Testing and Empanelment, Exchange Audits, Technology and System Audit, Compliance Requirements.

Text Books:

1. Raja Velu, Maxence Hardy and Daniel Nehren, "Algorithmic Trading and Quantitative Strategies", CRC Press Taylor and Francis Group, Florid, 2020.
2. Sebastien Donadio, Sourav Ghosh, "Learn Algorithmic Trading: Build and Deploy Algorithmic Trading Systems and Strategies Using Python and Advanced Data Analysis", United Kingdom: Packet Publishing 2019.

References:

Reference Books:

1. Conlan C, "Algorithmic Trading with Python: Quantitative Methods and Strategy Development" United States: Independently Published, 2020.
2. Satya R. Chakravarthy and Palash Sarkar, "An Introduction to Algorithmic Finance, Algorithmic Trading and Blockchain", Emerald Publishing, Bingley, 2020.

Journals:

1. Journal of Financial Markets

2. Journal of Financial and Quantitative Analysis (JFQA)
3. Journal of Portfolio Management
4. Journal of Computational Finance

Video References:

1. https://www.youtube.com/watch?v=f911dDCELX4
2. https://www.youtube.com/watch?v=5iuF42s6zNo
3. https://www.youtube.com/watch?v=kFnUxQ2OQgk
4. https://www.youtube.com/watch?v=u3aJCJSunWA
5. https://www.youtube.com/watch?v=9Y3yaoi9rUQ

MOOC/SWAYAM/NPTEL Courses:

1. https://nptel.ac.in/courses/110104169
2. https://nptel.ac.in/courses/110107144

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CB601.1	Recognize the trends and benefits of algorithmic trading
R19CB601.2	Analyze various order types and trading strategies
R19CB601.3	Appraise the system architecture for algorithmic trading
R19CB601.4	Obtain knowledge related to risk management in algorithmic trading
R19CB601.5	Understand the importance of audit and compliance process

R19CB602	Business Simulation	L	T	P	C
		3	0	0	3

1. Course Description:

Business Simulation is built around a computer-based business simulation of a technology company start-up. Students on the course are formed into company teams of six or so members who will self-allocate themselves into the different board of director roles (Strategy, Finance, Marketing, Operations, HR/Organisation and Innovation) to manage their simulated company through a series of five simulation rounds that represent two years in the life of the company.

2. Course Objectives:

1. Gain an understanding of integrating business management principles and practice the theory in an interdisciplinary environment
2. Develop skills that are necessary to solidify a business situation using what-if scenarios
3. Obtain the knowledge and skill to analyze a business process – not just at high-level.

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4. Work as a member of a team in completing everyday business tasks and making decisions relating to the overall operation of the business and growth of the business.
5. Apply critical thinking and problem-solving skills in a rapidly evolving environment
3. Syllabus:
Unit-I: Basic Simulation Modeling
The Nature of Simulation Systems: Models and Simulation with ExtendSim, Simulation of a Single Server Queuing System Simulation of an Inventory System Simulation with ExtendSim, Parallel/ Distributed Simulation, Steps in a Simulation Study Other types of Simulation
Unit-II: – Simulation Software
Introduction, Classification, Desirable Software Features, Simulation Software Demonstration, Simulation Software Demonstration
Unit-III: Probability and Statistics
Random Variables, Simulation Output Data and Stochastic Process, Simulation Output Data and Stochastic Process, Case studies, MODELNG COMPLEX SYSTEMS, List Processing in Simulation
Unit-IV: Simulator
Introduction to discrete event simulation and ExtendSim, ExtendSim Simulation, A panorama of ExtendSim models, Stochastic Optimization, Combining Solver and @Risk
Unit-V: System Design
Process Analysis and Variability, Staffing Small Service Systems, Staffing Large Service Systems, Network models, Comparison of Alternative Systems, Routing in Service Systems
Text Books:
1. Business simulation A Complete Guide-2020 Edition by Gerardus Blokdyk 2020. 2. Business Process Modeling, Simulation and Design Hardcover – 26 December 2018 3. Simulation Modelling Comcepts,Tools and Practical Business Applications by Andrew Greasley 2023
References:
Reference Books: 1. Contributions on Applied Business Research and Simulation Studies Mariya Gubareva (Editor) , Orlando Gomes (Editor),2020 2. The Big Book of Simulation Modeling:Multimethod Modeling with AnyLogic 8, Dr. Andrei Borshchev, Ilya Grigoryev,2019 3. Modeling and Simulation in Complex Project Management, Sergey Suslov, Dmitry Katalevsky2002. **Journals:** 1. Journal of Marketing Research 2. Journal of International Marketing 3. Journal of Vacation Marketing 4. Journal of Academy of Marketing Science **Video References:** 1. https://www.youtube.com/watch?v=FO_nOu1nhcs 2. https://www.youtube.com/watch?v=IP0cUBWTgpY

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3. https://www.youtube.com/watch?v=kMfXH2vuPX0 4. https://www.youtube.com/watch?v=wYMh0nHCKKk 5. https://www.youtube.com/watch?v=oxN6FYjBDso **MOOC/SWAYAM/NPTEL Course:** 1. https://onlinecourses.nptel.ac.in/noc20_mg05/preview/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CB602.1	Develop a managerial approach to analyzing business problems.
R19CB602.2	Apply the skills necessary to develop corporate, business level and functional level strategies that will create competitive advantages and be able to defend their selection for a particular business situation
R19CB602.3	Demonstrate an ability to apply general management know-how as a member of a team in a simulated business setting.
R19CB602.4	Apply critical thinking and problem-solving skills in a rapidly evolving environment
R19CB602.5	Apply problem solving processes within a business context

R19CB603	Principles of Taxation	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides an in-depth understanding of the principles and practices of taxation. It covers various types of taxes, the legal and regulatory framework governing taxation, and the impact of taxes on business decisions.

2. Course Objectives:

1. Understand the fundamental principles of taxation.
2. Analyze different types of taxes and their implications for businesses.
3. Apply tax laws and regulations in practical scenarios.
4. Evaluate the impact of tax policies on business strategy and operations.
5. Develop skills to engage with tax professionals and authorities effectively.

3. Syllabus:

Unit-I: Introduction to Taxation

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Definition and purpose of taxation, History and evolution of taxation, Key concepts in taxation; Types of Taxes: Income tax, Corporate tax, Sales and use tax, Property tax, Value-added tax (VAT) and Goods and Services Tax (GST)
Unit-II: Taxation of Individuals
Income Tax for Individuals: Taxable income, Deductions and exemptions, Tax credits, Filing status and requirements, Tax rates and brackets; Tax Planning for Individuals: Retirement accounts and tax implications, Estate and gift taxes, Tax-efficient investment strategies, Health savings accounts (HSAs), Education-related tax benefits
Unit-III: Corporate Taxation
Corporate Income Tax: Taxable income for corporations, Deductions for businesses, Tax credits and incentives, Depreciation and amortization, corporate tax rates and compliance; International Taxation: Taxation of multinational companies, Transfer pricing, Tax treaties and agreements, Foreign tax credits, Base erosion and profit shifting (BEPS)
Unit-IV:Tax Administration and Compliance
Tax Filing and Reporting: Tax forms and filing requirements, electronic filing and recordkeeping, Deadlines and penalties, Role of tax authorities, Common filing errors and how to avoid them; Tax Audits and Dispute Resolution, Process of tax audits, Handling tax disputes, Legal recourse and appeals, Documentation and evidence, Working with tax professionals
Unit-V: Tax Policy and Economic Impact
Tax Policy Analysis: Principles of tax policy, Impact of taxation on economic behavior, Tax reform and policy changes, Comparative tax systems, Political and social considerations in tax policy; Fiscal Policy and Taxation: Relationship between taxation and government spending, Taxation and economic growth, Equity and efficiency in taxation; Case Studies in Taxation: Analysis of real-world tax issues, Lessons from notable tax cases, Group presentations on tax scenarios
Text Books:
1. "Federal Income Taxation" by Joseph Bankman, Thomas D. Griffith, and Katherine Pratt 2. "Principles of Taxation for Business and Investment Planning" by Sally Jones and Shelley Rhoades-Catanach 3. Taxation: Finance Act 2023" by Alan Melville
References:
Reference Books: 1. "International Taxation in a Nutshell" by Mindy Herzfeld and Richard L. Doernberg 2. "Taxation for Decision Makers" by Shirley Dennis-Escoffier and Karen A. Fortin

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3. "South-Western Federal Taxation: Comprehensive Volume" by William H Hoffman, Jr., James C. Young, William A. Raabe, and David M. Maloney

Journals:

1. The Journal of Taxation
2. Tax Law Review
3. The National Tax Journal
4. Tax Notes

Video References:

1. https://www.youtube.com/watch?v=cXX8pBPU8tU
2. https://www.youtube.com/watch?v=LX9L0Rxa7ww
3. https://www.youtube.com/watch?v=d5YhN8o4j9A
4. https://www.youtube.com/watch?v=pmAcG9GxnwY
5. https://www.youtube.com/playlist?list=PLerzWq9nGRYciYtps9nWhdHiJG2bUignt
6. https://www.youtube.com/watch?v=wZ8A81tI3XQ

MOOC/SWAYAM/NPTEL Course:

1. https://nptel.ac.in/courses/112107209

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CB603.1	Demonstrate a solid grasp of taxation fundamentals, encompassing the essential purpose and historical evolution of taxation
R19CB603.2	calculate taxable income for individuals, apply deductions, exemptions, and tax credits, and strategize tax planning techniques tailored to individual circumstances,
R19CB603.3	Analyze corporate taxation principles, including taxable income determination, deductions, and incentives, as well as navigate international tax issues
R19CB603.4	Develop practical skills in tax filing, reporting, and compliance, including understanding tax forms, electronic filing, and audit procedures,
R19CB603.5	Analyzation of Tax Policy and Economic Impact

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R19CB604	Strategic Business Leader	L	T	P	C
		3	0	0	3

1. Course Description:

Explore the multifaceted landscape of modern business through this comprehensive course. Delve into the realms of Leadership and Governance, analyzing leadership qualities, organizational culture, and ethical standards. Understand the intricacies of Strategy and Risk, navigating environmental challenges, competitive forces, and risk management strategies. Embrace the transformative power of Technology and Data Analytics, exploring cloud computing, big data, and IT security. Gain insights into Organizational Control, Audit, and Finance, mastering management systems, compliance, financial analysis, and decision-making techniques.

2. Course Objectives:

1. Understand leadership qualities and ethical codes for effective organizational governance.
2. Analyze strategic choices and manage risks for sustainable competitive advantage.
3. Utilize technology and analytics for enhancing organizational performance and innovation.
4. Implement control mechanisms and financial analysis for informed decision-making and compliance.
5. Foster innovation, manage change, and develop professional skills for organizational excellence.

3. Syllabus:

Unit-I: Leadership and Governance

Leadership: Qualities of leadership, Leadership and organizational culture, Professionalism, ethical codes and the public interest; Governance: Agency, Stakeholder analysis and organisational social responsibility; Governance, scope and approaches; Reporting to stakeholders; The board of directors; Public sector governance.

Unit-II: Strategy and Risk

Strategy: Concepts of strategy, Environmental issues, Competitive forces, The internal resources, capabilities and competences of an organisation, Strategic choices; Risk: Identification, assessment and measurement of risk, Managing, monitoring and mitigating risk.

Unit-III: Technology and Data Analytics

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Technology: Cloud and mobile technology, Big data and data analytics, E- business value chain, IT systems security and control.

Unit-IV: Organisational control and audit, Finance in planning and decision-making

Organisational control: Management and internal control systems, Audit and compliance, Internal control and management reporting; Finance: Function, Financial analysis and decision-making techniques, Cost and management accounting.

Unit-V: Innovation, Performance Excellence and Change Management

Enabling success: Organising, disruptive technologies, talent management, performance excellence; Managing strategic change; Innovation and change management; Leading and managing projects; Professional skills: Communication, Commercial acumen, Analysis, Scepticism and Evaluation.

List of Laboratory Experiments:

1. Written Case Study Analysis - Analyze a case study on leadership and ethics, proposing solutions.
2. Stakeholder Engagement Exercise - Develop a stakeholder engagement plan for a given scenario.
3. Strategic Decision Analysis - Analyze a case study, develop a strategic plan with risk mitigation.
4. Risk Assessment Report - Conduct a risk assessment, and propose mitigation strategies in a report.
5. Data Analytics Project Proposal - Propose a data analytics project with objectives and methodology.
6. Internal Control Assessment - Assess internal controls, propose improvements in an audit report.

Text Books:

1. Organizational Culture and Leadership, 5th Edition by Edgar H. Schein with Peter Schein, Wiley Publishers.
2. "Strategic Management: Concepts and Cases" by Fred R. David and Forest R. David, Pearson, 2015
3. Innovation and Entrepreneurship" by Peter F. Drucker, Harper & Row, 1985

References:

Reference Books:

1. Financial Management by I.M. Pandey, Vikas Publishing House PVT Ltd.
2. Big-Data Analytics for Cloud, IoT and Cognitive Computing by Kai Hwang, Min Chen, Wiley

3. Publishers 4. Managing Innovation and Change by David Mayle, Sage publishing **Journals:** 1. Journal of Leadership & Organizational Studies 2. Strategic Management Journal 3. Financial Analysts Journal **Video References:** 1. https://www.youtube.com/watch?v=lmyZMtPVodo 2. https://www.youtube.com/watch?v=u6XAPnuFjJc 3. https://www.youtube.com/watch?v=4y_kGc1GdhQ **MOOC/SWAYAM/NPTEL Course:** 1. https://onlinecourses.nptel.ac.in/noc19_mg34/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CB604.1	Apply leadership qualities and ethical codes to foster effective governance within organizational contexts.
R19CB604.2	Apply strategic thinking to assess competitive forces and manage risks for organizational sustainability and growth.
R19CB604.3	Analyze the impact of technology and data analytics on organizational performance and innovation across the e-business value chain.
R19CB604.4	Analyze organizational control mechanisms and financial data to inform decision-making processes and ensure compliance with regulatory standards.
R19CB604.5	Analyze strategies for fostering innovation, managing change, and developing professional skills to enhance organizational performance and adaptability.

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R19CB605	Information Systems Control and Audit	L	T	P	C
		3	0	0	3

1. Course Description:

This subject allows students to acquire, in pedagogic terms, the basic core knowledge of the field of Information Systems Audit and Control, the audit process and the protection of information, consistent with the ISACA Model Curriculum (Note 1), and to develop, in pragmatic terms, the necessary background and skills needed to enter the Information Systems Audit and Control profession.

2.Course Objectives:

1. Introduce students to the fundamental concepts, procedures and standards of IS audit and controls;
2. Describe the qualifications needed to enter and become successful in this field
3. Develop students' practical skills in handling various types of IS audits and examining the IS controls
4. Prepare students to develop generic skills in communication, individual and team works
5. Study the case analysis and reporting, and creative problem solving

3.Syllabus:

Unit-I: Introduction

Introduction: Information systems and auditing, Conducting an information system audit

Unit-II: The Management Control Framework

The Management Control Framework: Top Management Controls, Systems Development Management controls, Programming Management Controls, Data Resource Management Controls, Security Management Controls, Operations Management Controls, Quality Assurance Management Controls

Unit-III: Application Control Framework

The Application Control Framework Boundary Controls, Input Controls, Communication Controls, Processing Controls, Database Controls, Output Controls

Unit-IV: Evidence Collection and Evaluation

Evidence Collection and Evaluation - Audit Software - Code Review, Test Data, and Code Comparison - Concurrent Auditing Techniques 9 17 - Interviews, Questionnaires, and Control Flowcharts - Performance Measurement Tools - Evaluating Asset Safeguarding and Data Integrity - Evaluating System Efficiency and Effectiveness

Unit-V: Information System Audit and Management

Information System Audit and Management Managing the Information systems audit function, Practical: Carry out the audit of an IS.

Text Books:

1. Ron Weber- Information Systems Control and Audit
2. Wendy Robson -Strategic Management & Information Systems

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3. Mohan Bhatia- Auditing in a Computerized Environment 4. 4. Chris Davis -IT Auditing: Using Controls to Protect Information Assets
References:
Reference Books: 1. Hunton, J.E., Bryant, S.M., and Bagranoff, N.A., Core Concepts of Information Technology Auditing, John Wiley & Sons, 2004 2. Champlain, J.J., Auditing Information Systems, John Wiley, 2003 3. CISA Review Manual, ISACA **Web Resource:** 1. ISACA publications including IS Audit & Control Journal

4.Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CB605.1	Understand the role of the IS auditor and the IS audit function
R19CB605.2	Understand the purpose of controls in an information systems environment
R19CB605.3	Learn how access to systems, resources, and data can be controlled
R19CB605.4	Understand some of the basic theory underlying computer security policies, models, and problems
R19CB605.5	Understand the basic issues in auditing computer security policies and mechanisms

R19CS651	**Application Development using Java**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

1. Course Description:

This course provides students with a comprehensive understanding of the principles, mechanisms and advanced features of the Java programming language. Starting with the Foundations of Java, students will build a solid understanding of basic syntax, data types, control structures, and object-oriented concepts. They will explore into Object-Oriented Mechanisms, mastering topics such as classes, objects, inheritance, polymorphism and encapsulation. The course also covers essential Java libraries and features, including Strings, Collections, Java 8 Features, Exception Handling, and Multithreading. Additionally, students will explore JavaFX for graphical user interface (GUI) development and JDBC for database connectivity, enhancing their proficiency in Java application development.

2.Course Objectives:

1. To understand object-oriented programming concepts and the basics of java programming language
2. To know the principles of packages, inheritance and interfaces

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3. To understand strings & collections with java 8 features 4. To develop a Java application with exception handling and threads 5. To develop windows-based applications with jdbc
3.Syllabus:
Unit-I: Foundations of Java
Overview of OOP , Object oriented programming paradigms , Features of Object Oriented Programming; Java Buzzwords ; Overview of Java , JVM , JDK ; Programming Structures in Java , Objects & Classes in Java , Data Types, Variables , Operators , Keywords , Control Statements; Wrapper Classes ; Constructors , Methods , Access specifiers , Garbage Collection ; Arrays & its types ; java.util.Arrays ; Java Doc comments ; I/O classes
Unit-II: Object Oriented Mechanisms
Association, Aggregation, Composition, Polymorphism; Inheritance, Basics, Types of Inheritance, Super, static & final keywords with inheritance and polymorphism; Overloading Vs Overriding , Static and Dynamic Binding ; Abstraction , Abstract Classes and Interfaces , Encapsulation , Packages , Access modifiers
Unit-III: Strings, Collections & Java 8 Features
Types of Classes in Java, Strings, creation, declaration of a string , Mutable & Immutable Strings , Storage structure of a string and its methods, StringBuilder , String Buffer, regex ; Collection Interface ; Generics - List, Set, Map interfaces and classes, Comparable , Comparator ; Java lambda expressions , Date & time Object in java 1.8 and its functions, Streams
Unit-IV: Exception Handling and Multithreading
Exception handling, Hierarchy, Types of exceptions, Mechanisms - try, catch, throw, throws and finally, Exception Propagation, Exception in Inheritance; Introduction to Multiprocessing, threads vs process, threads, Creation of thread , Thread states , Thread Lifecycle and its methods, Executor Framework, Concurrency API, Synchronization Blocks
Unit-V: JAVAFX & JDBC
JAVAFX Events and Controls: Event Basics, Handling Key and Mouse Events; Controls: Checkbox, Toggle Button, Radio Buttons, List View, Combo Box, Choice Box, Text Controls, Scroll Pane. Layouts, Flow Pane, HBox and VBox, Border Pane, Stack Pane , Grid Pane; Menus , Basics , Menu bars , Menu Item ; JDBC – drivers, Steps to create a JDBC application , DB Connection Pool
Text Books:
1.Herbert Schildt, "Java: The Complete Reference", 12th Edition, McGraw Hill Education, New Delhi, 2019 2.Cay S.Horstmann, "Core Java Fundamentals", Volume 1, 11th Edition, Prentice Hall, 2018
References:
References Books:
1. Deitel P and Deitel H, "Java: How to Program", 11th Edition, Prentice Hall, 2018 2. James Gosling, Bill Joy, Guy Steele, Gilad Bracha, Alex Buckley and Daniel Smith, "The Java Language Specification – Java SE", 13th Edition, Oracle America Inc., USA, 2019 3. Matt Weisfeld, "The Object-Oriented Thought Process", 5th Edition, Addison-Wesley Professional, US, 2019

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Video References:

1. https://www.youtube.com/@abdul_bari/videos
2. https://www.youtube.com/@JennyslecturesCSIT
3. https://caveofprogramming.teachable.com/p/java-multithreading

MOOC/ NPTEL/ SWAYAM Courses:

1. https://www.udemy.com/course/java-se-programming/
2. https://cse.iitkgp.ac.in/~dsamanta/java/index.htm
3. https://caveofprogramming.teachable.com/p/java-for-complete-beginners

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS651.1	Understand the core concepts of Java programming
R19CS651.2	Understand the principles of object-oriented programming
R19CS651.3	Understand the concepts of strings and collections
R19CS651.4	Apply exception-handling & multithreading concepts in applications
R19CS651.5	Apply JavaFX & JDBC in application development

R19CS652	**Database Technologies**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

1.Course Description:

This course offers a comprehensive exploration of Database Management Systems (DBMS) theory, focusing on essential concepts and principles underlying the design, implementation and optimization of databases. Students will explore into various topics, including an Introduction to Databases, Structured Query Language (SQL) & Procedural Language/SQL (PL/SQL), Transaction and Concurrency Control, Storage & Indexing, and NoSQL databases. The students will gain a deep understanding of database architectures, data modelling techniques, query languages, transaction management strategies, storage mechanisms, indexing methods and the role of NoSQL databases in modern data management.

2.Course Objectives:

1. To enable students to understand the fundamental concepts and principles of database management.
2. To teach students to master the database querying and programming using SQL and PL/SQL
3. To foster students to learn the principles and mechanisms of transaction processing and concurrency control
4. To familiarize students to design and implement efficient database storage and indexing solutions
5. To acquaint students to effectively use NoSQL databases to build scalable, high-performance applications

3.Syllabus:

Unit-I: Introduction to Databases

Purpose of Database – Types and examples of Databases (RDBMS, NOSQL, In-memory Databases & Distributed SQL databases)– Relational Database System Architecture - Views

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of Data– Schema architecture – Data Independence – Schema and instance- Data Models– Benefits and Phases of Data Model - ER Diagram - Symbols, Components, Relationships, Weak entities, Attributes, Cardinality - Extended ER Diagram – Examples- Relational Data Model – Keys - Relational Algebra-Normalization - 1NF, 2NF, 3NF, BCNF,4NF,5NF Case Study: ER Diagram on Online Streaming, Movie Ticket Recommendation, Bike Tracking
Unit-II: SQL & PL/SQL
SQL Fundamentals – DDL Commands - Create, Drop, Alter, Truncate, Rename, Keys - Primary Key, Candidate Key, Super Key, Foreign Key – DML Commands – DQL Commands - Select, Insert, Update, Delete, Any, All, In, Exists, Non-Exists, Union, Intersection, Advanced SQL Features –Aggregate Functions - SUM, COUNT, AVG, MIN, MAX, EXPLAIN, COALESCE - Clauses – Order By - Group By, Having, CASE, LIMIT,WITH Clause, Date Functions, String Functions -Subqueries - Nested, Correlated, Joins- Inner, Outer, and Equi-Joins - Order of Execution, Embedded SQL- Dynamic SQL. Creation and Dropping of Views, Types of Views - Creation and Execution of Stored Procedures - Cursors - Opening, Fetching, and Closing - Triggers - Creation, Insertion, Deletion, and Updating Database - Exception Handling - MySQL JDBC Connectivity Case Study: Online Streaming, Movie Ticket Recommendation, Bike Tracking, Import/Export Random records from CSV file to MYSQL
Unit-III: Transaction and Concurrency Control
Transaction processing - ACID Properties - Failure and Recovery – Schedules – Serializability - Concurrency Control –Lock-based protocol - Isolation levels - SQL Facilities for concurrency and recovery- Database Integrity, Security and Authorization Case Study: ACID Properties in Online Streaming Database
Unit-IV: Storage & Indexing
Overview of Storage Techniques – File organization - RAID –Indexing - Types of ordered indices - B & B+ tree – Hashing - Static & Dynamic Hashing - Query Processing & Optimization – SQL Performance Tuning Case Study: Indexing in Online Streaming Database to optimize the retrieval of data
Unit-V: NOSQL
Need for NO SQL – Characteristics of NOSQL - Key-value database - Columnar Databases - Apache Cassandra – Click House– Document Databases - MongoDB – CRUD operations with MongoDB - MongoDB JDBC Connectivity –MongoDB Testing - Graph Databases – Metabase Case study: Conversion of Online Streaming Database (RDBMS) to MongoDB
4.List of Laboratory Experiments / Exercises:
Design a project for the following application using JDBC Connectivity • Online Food Ordering System

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- Online Movie Ticket Booking System
- Online Parking System
- Online Hotel Room Booking System

1 ER Diagrams

Create an Entity Relationship model for the above applications

2 SQL Queries

Develop the SQL Queries using the following commands for the database

a. DDL commands - Create, alter (Add, Modify, Rename), Truncate, Drop commands

b. DML commands - Insert, Update, and Delete commands

c. DQL commands - Select and its basic operations

d. DCL commands - Commit, Rollback, and Savepoint operations

e. TCL commands - Grant and Revoke operations for the different users

3 Implementation of Key constraints

a. Build the Integrity Constraints - Unique, NOT NULL, Auto Increment, Primary Key, Foreign Key, Check, Default constraints for the given databases

4 Advanced SQL Queries

Implementation of Aggregate Functions

a. Find the total count of all the records in the table

b. Find the average value of a specific column in the table

c. Find the maximum/min/sum value of a specific column in the table

d. Find the count of all distinct values in a specific column in the table

5 Implementation of Group By Clause

a. Find the average/max/min/sum of all values of a specific column for each group records in the table

b. Find the count/average/max/min of all records in the table grouped by multiple columns

6 Implementation of OrderBy Clause

a. Sort the list of all records in the table by multiple columns/specific columns in ascending or descending order

b. Find the top/ bottom 10 records in the table sorted by a specific column/multiple columns

c. Find the list of all records in the table sorted by a specific column/multiple columns and limited to a certain range

7 Implementation of String Functions

a. Find the length of characters in a specific string

b. Find the leftmost/rightmost portion of a specific string up to a certain character or length

c. Find the specific portion of a string extracted using a regular expression pattern

d. Find the specific string with all occurrences of a certain character or pattern replaced with another character or string

e. Find the specific string converted to uppercase or lowercase

f. Find the specific string with leading or trailing whitespace characters removed

g. Find the specific string with a certain character or substring removed or replaced

h. Find the specific string with a certain character or substring added at a certain position

i. Find the specific string with all occurrences of a certain substring concatenated with another substring

8 Implementation of Date function

a. Find the current date and time in MySQL

b. Find the day of the week for a specific date in MySQL

c. Find the month/year for a specific date in MySQL

d. Find the difference between two specific dates in MySQL

e. Find the date in MySQL after adding/subtracting a specific number of days to a specific date.

f. Find the number of days/average time between two specific dates in MySQL

g. Find the earliest or latest date in a specific column of the table in

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MySQL

9 Implementation of Nested queries

a. Find the maximum/min/count/sum/average/distinct count value of a specific column in the table for a specific subset of records selected using a nested query

b. Find the average/max/sum/count/min value of a specific column in the table where the value of another column is equal to a specific value selected using a nested query

c. Find the maximum value of a specific column in the table for a specific subset of records selected using a nested query within another nested query

10 Implementation of Joins

a. Find the result of an inner/left/right/full outer/cross joins between two/multiple tables on a specific column in MySQL

11 Construction of Index

a. Create an index for the database and show the comparative analysis of Query execution time with and without using an index for the given scenario

12 Implementation of views

a. Perform the DDL, DML, and DQL operations on the views and check the consistency of the relations

b. Create different types of views and their categories of the REFRESH command.

c. Implement the materialized views with Aggregate and Join queries

13 PLSQL

Develop a program in PLSQL using Before/After trigger, row, and statement trigger and instead of trigger

a. Develop a program in PLSQL using Before/After trigger, row, and statement trigger and instead of trigger.

b. Create a trigger and check for the before/after insertion, update, and deletion operations in the table.

14 NOSQL

Implementation of MongoDB application and run through CRUD operations

a. Command to create a collection and a document in MongoDB

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b. Command to insert/update/delete a document in a MongoDB collection

c. Command to query a MongoDB collection to retrieve documents that meet certain criteria

d. Command to use aggregation pipelines to perform more complex queries in MongoDB

e. Command to create an index in MongoDB to improve query performance

15 Create tables and execute the queries using Click House

a. Command to create a table, view, and functions

b. Command to insert the data in a table from compressed files, Infiles, and multiple files

c. Command to query the data using the SELECT, WHERE, JOIN, GROUPBY, HAVING clauses command to query the data using the Regular, Aggregate, and Table functions

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan —" Database System Concepts", Sixth Edition, Tata McGraw Hill, 2013
2. Ramez Elmasri, Shamkant B. Navathe —" Fundamentals of Database Systems", Sixth Edition, Pearson Education, 2014

References:

References Books:

1. C.J.Date, A.Kannan, S. Swamynathan, —" An Introduction to Database Systems", Eighth Edition, Pearson Education, 2013
2. Krisitna Chodorow, "MongoDB – The Definitive Guide", O' Reilly, 2013

Video References:

1. https://www.youtube.com/playlist?list=PLsjUcU8CQXGFFAhJI6qTA8owv3z9jBbpd
2. https://www.youtube.com/watch?v=c5HAwKX-suM
3. https://youtu.be/FNYdBLwZ6cE
4. https://youtu.be/qEhNHOEa5sE

MOOC/ NPTEL/ SWAYAM Courses:

1. https://onlinecourses.NPTEL.ac.in/noc23_cs41/preview
2. https://codewithmosh.com/p/complete-sql-mastery
3. https://www.udemy.com/course/nosql-databases-for-beginners/

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS652.1	Use data models and depict a database system
R19CS652.2	Design relations for various business requirements
R19CS652.3	Understand the properties of the database and recovery process
R19CS652.4	Understand the optimization techniques in database storage
R19CS652.5	Design non-structured database systems in application development

R19CS653	**Full Stack Technologies**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

1. Course Description:

This is a comprehensive course designed to equip students with the knowledge and skills required to become proficient full-stack developers. The course covers essential front-end and back-end technologies, including HTML5, CSS3, JavaScript, React.js, Node.js with Express.js, Spring Boot backend framework, and fundamentals of MongoDB. Through a combination of theoretical lectures, hands-on coding exercises, and real-world examples, students will gain a deep understanding of each technology's role in the development process and how they work together to build modern web applications

2.Course Objectives:

1. To empower students to design, develop, and deploy dynamic web applications using HTML5, CSS3, and JavaScript
2. To introduce students to build fast, scalable, and maintainable front-end applications using ReactJS
3. To familiarize students with the skills to effectively use MongoDB to build robust, scalable, and data-driven applications
4. To acquaint students to build scalable and efficient web applications using Node.js and Express.js
5. To equip students with the skills to master Spring Boot's core features

3.Syllabus

Unit-I: HTML5, CSS3 and JavaScript

Full Stack Application: component; HTML5: tags, attributes, properties, importance of semantic HTML, classes; CSS3: CSS3 syntax, properties, borders, text, image, grid layout, media queries, animations; Types of CSS frameworks; Overview of JavaScript: advanced

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working with functions; JavaScript namespaces; Prototypes; Error handling; Modules in JavaScript

Case Study: Website design for an automobile industry

Unit-II: ReactJS

ReactJS: library, directory; React components: types of Components, component composition, component styling, adding styles, component intercommunication, data sharing, routing; Hooks: states, hooks vs states, types of Hooks; React bootstrap: props, router

Case Study: Portfolio development with authentication

Unit-III: MongoDB

MongoDB: features, environment; Data modelling: Schema creation using Mongoose (ODM), create database, data types, drop database; Collection: insert, query, update and delete; Projection: limiting records, sorting records, indexing and aggregation

Case Study: Design of a simple search engine

Unit-IV: Node JS and Express JS

NodeJS: node module system, Node Package Manager (NPM); ExpressJs: building RESTful API's; Advanced topics: asynchronous JavaScript, CRUD operations using Mongoose, mongo data validation, mongoose modeling relationships between connected data

Case Study: QR Code Generator application

Unit-V: Spring Boot

Spring Boot: configuration, spring data JPA, create spring data repositories for JPA, web application with Spring Boot, RESTful controllers, message converters, WAR / JAR deployment, creating a RESTful application, HTTP GET, PUT, POST, DELETE

Case Study: Real time message transfer application

List of Laboratory Experiments / Exercises:

1. Develop a music streaming web application to provide users with a seamless and interactive music listening experience. Users should be able to discover, play, and share their favourite music in real-time. The application should support multiple features such as user authentication, personalized playlists, real-time updates on trending tracks, and social sharing capabilities

2. Build a video conferencing web application that facilitates seamless communication between individuals or groups through high-quality video and audio interactions and supports real-time features, user authentication, screen

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sharing to enhance the overall video conferencing experience

3. Develop a dynamic and engaging social media platform web application that connects users globally. The platform aims to provide a seamless and real-time social experience, allowing users to connect, share content, and interact with each other and should incorporate features such as user profiles, real-time feed updates, multimedia content sharing, instant messaging, and community building

4. Create a web application that constitutes a dynamic Content Management System (CMS) tailored for blogging that allows users to effortlessly create, manage, and share blog content and provides an intuitive interface, support multimedia content, and facilitate collaboration among multiple authors

5. Build a web application designed to serve as a real-time Project Management Dashboard to streamline project management processes, enhance collaboration, and provide stakeholders with a dynamic and comprehensive view of project progress. The application should offer real-time updates, intuitive navigation, and advanced project tracking features.

6. Design a web application to perform real-time analytics for data-driven decision-making. This web application aims to empower users to analyze, visualize, and derive insights from streaming data that will be suitable for industries requiring instantaneous data processing, such as finance, e-commerce environments

7. Develop a web application designed to revolutionize the job search process to provide job seekers with real-time access to a diverse range of job opportunities, personalized recommendations, and interactive tools to streamline the entire job searching experience

8. To develop an online crowdfunding web application to facilitate real-time creative financing for innovative projects. which acts as a catalyst for novel ideas by providing a dynamic platform where creators can present their visions, attract support, and turn aspirations into tangible achievements

9. Build a To-Do List web application elevates the task management experience through real-time collaboration and user authentication. This application provides users with an intuitive platform for creating, organizing, and collaborating on to-do lists in real-time, ensuring secure access and personalized task management

10. Develop a chat web application to facilitate real-time communication and collaboration. The web application aims to provide users with a seamless and interactive platform for one-on-one and group chats, ensuring instant messaging, multimedia sharing, and a user-friendly experience

11. Develop a comprehensive web application to empower users with a real-time expense tracking system for efficient money management that constitutes users with a user-friendly interface, real-time financial insights, and personalized

budgeting features to help them make informed financial decisions and achieve their financial goals 12. Design a gaming web application that offers a real-time multiplayer gaming experience to provide users with a diverse range of games, interactive features, and a social gaming environment, allowing players to connect, compete, and collaborate in real-time
Project:
Develop a project for any of the above use cases using the MERN stack
Text Books:
1. Vasan Subramanian, 'Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node', Second Edition, Apress, 2019 2. Brad Dayley, Brendan Dayley, Caleb Dayley, 'Node.js, MongoDB and Angular Web Development', Addison-Wesley, Second Edition, 2018
References:
1. Chris Northwood, 'The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer', Apress; 1st edition, 2018. 2. Kirupa Chinnathambi, 'Learning React: A Hands-On Guide to Building Web Applications Using React and Redux', Addison-Wesley Professional, 2nd edition, 2018.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS653.1	Build dynamically enriched web pages with HTML5, CSS3, and JavaScript
R19CS653.2	Implement data handling and fetching in React applications using state management libraries
R19CS653.3	Develop a web application with MongoDB as the backend
R19CS653.4	Develop ExpressJS applications that define routes and handle HTTP requests and responses
R19CS653.5	Develop RESTful APIs with Spring Boot for resource representation, HTTP methods and error handling

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R19CS654	Fundamentals of Python Programming	L	T	P	C
		2	0	2	3

1.Course Description:

This course covers the fundamental concepts and practical applications of Python programming. Students will explore topics ranging from basic data types and expressions to advanced data manipulation and visualization techniques. The course will delve into programming paradigms, emphasizing Python's versatility in supporting imperative, functional, and object-oriented programming styles. Through hands-on exercises, projects, and real-world examples, students will develop a strong foundation in Python programming, enabling them to write efficient, readable, and maintainable code for various applications.

2.Course Objectives:

1. To learn to solve simple problems with Python programs
2. To choose and use data structures such as lists, tuples, dictionaries and sets in Python programs
3. To understand file operations in Python
4. To implement object-oriented programming constructs in Python
5. To learn to use libraries for data analysis in Python and use Django framework for web application development

3.Syllabus

Unit-I: Python Constructs

Introduction: Python Interpreter and interactive mode, Comments, Identifiers and Keywords; Data Types; Variables and Expressions; Operators; Conditional Statements; Looping Statements; Fruitful Functions; Lambda Function

Illustrative Programs: Financial application, sandwich vowel, and Chocolate Distribution Algorithm

Unit-II: Lists, Tuples, Dictionaries and Set

Lists: operations - Processing Array elements, slices, methods, loop, mutability, aliasing, cloning, parameters, lists as arrays; Tuples: assignment, tuple as return value; Dictionaries: operations and methods; Sets: operations;

Illustrative Programs: Dutch National Flag Algorithm, Count and Say Problem and Kadanne's Algorithm

Unit-III: Files, Modules and Packages

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Files: text files, reading and writing files; Format Operator; Command Line Arguments; Error and Exception Handling; Modules; Packages; Locating path of modules – Python Date – Python Regex. Illustrative Programs: Bank Management application using File concept
Unit-IV: OOP and Databases
Object, class, constructor, inheritance, abstraction, polymorphism, encapsulation; MongoDB: Environmental Setup, creating new Database, CRUD Operations, Python DB connectivity Application: Event management using MongoDB, Real Estate management using MongoDB.
Unit-V: Data Analysis and Web Frameworks
NumPy: Basics of NumPy Arrays; Computations: Universal Functions; Aggregations: Min-Max and Everything in Between; Pandas: Objects, Data Indexing and Selection, Data Operations, Handling Missing Data; Matplotlib: Types of plots, Simple Line Plots, Boxplots, Simple Scatter Plots; Django: Overview, Introduction to MVC and MVT architecture in Web development, Django folder structure, generic views, HTML templates Illustrative Programs: Graph Plotting for performance Analysis, form design, webpage design
4.List of Laboratory Experiments / Exercises:
1. Create a Python application that uses expressions and control flow statements to automate a common task. Ensure that your application is user-friendly and robust to different inputs. Suggested Problems: Swap two numbers without a temporary variable, Quadratic Equation, Valid Palindrome 2. Implement a Python program that simulates a real-world system or process using conditions and iterative loops. Suggested Problems: check whether an alphabet is a vowel or consonant, sum of all even numbers from 0 to n, factorial of a number 3. Implementation of Strings in the program. Suggested Problems: Determine if string halves are alike, palindrome, character count, replacing characters 4. Implementation of real-time/technical applications using Lists and Tuples.

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Suggested Problems: Minimum Index Sum of Two Lists, concatenate two lists index-wise, Tuple with the same product, Copy specific elements from one Tuple to a new tuple)

5. Implementation of real-time applications using Set and Dictionaries.

   Suggested Problems: Magic Dictionary, Longest Word in Dictionary, Set Mismatch and Smallest Number in Finite Set

6. Implementation of Functions in the program.

   Suggested Problems: Factorial, largest number in a list, area of shape

7. Implementation of file-handling operations.

   Suggested Problems: copy from one file to another, wordcount, longest word

8. Implementation of applications of standard libraries.

   Suggested Problems: Handle scalars to work on the NumPy array, Insert values at random positions in an array, Convert the index of a series into a column of a data frame, Combine many series to form a data frame, Get frequency counts of unique items of a series, Union of two arrays, Convert a NumPy array to a data frame of a given shape, Plotting datasets.

9. Implementation of OOP concepts in Python.

References:

References Books:

4. Al Sweigart, "Automate the Boring Stuff with Python: Practical Programming for Total Beginners," 2nd Edition, No Starch Press, 2019
5. Liang Y. Daniel, "Introduction to Programming Using Python," Pearson Education, 2017
6. Jake Vander Pla, "Python Data Science Handbook," O'Reilly (https://jakevdp.github.io/PythonDataScienceHandbook)
7. William S Vincent, "Django for Beginners: Build Websites with Python and Django," Welcome to Code Publishers, 2020

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS654.1	Apply syntax and semantics of Python programming language for developing real-world applications
R19CS654.2	Analyse Python solutions by implementing lists, tuples and dictionaries
R19CS654.3	Create file system applications with built in functions
R19CS654.4	Apply principles of OOP and MongoDB
R19CS654.5	Analyse data manipulation techniques and develop web pages with Django Framework

		L	T	P	C
R19CS655	**Competitive Coding Techniques**	2	0	2	3

1.Course Description:

This course is designed to enhance problem-solving and programming skills required for competitive programming and coding interviews. Students will explore advanced algorithms and data structures, and develop strategies for tackling complex coding challenges under time constraints.

2.Course Objectives

1. To understand the fundamentals of competitive programming`
2. To apply the advanced concepts data structures techniques
3. To apply the advanced algorithmic techniques in data structures
4. To apply the advanced searching and graph data structures techniques

3.Syllabus

Unit I: Introduction to Competitive Programming

Overview of Competitive Programming - Common Online Judges (Codeforces, AtCoder, CodeChef, etc.) - Input/Output techniques - Time and Space Complexity Analysis - Big O Notation - Common Complexity Classes - Basic Math and Number Theory for CP - Prime numbers, GCD, LCM, Factorization - Modular arithmetic - Introduction to Data Structures in CP (Arrays, Lists, Sets)

Unit-II: Advanced Data Structures

Stacks and Queues - Priority Queues and Heaps - Applications in CP - Trees and Graphs - Traversals (DFS, BFS) - Shortest Paths (Dijkstra's and Floyd-Warshall algorithms) - Advanced Data Structures (Segment Trees, Fenwick Trees) - Applications in CP - Disjoint

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Set Union (Union-Find)
Unit-III: Algorithmic Techniques
Greedy Algorithms - Applications in CP - Fractional Knapsack (Greedy) - Huffman Coding (Greedy) - Dynamic Programming (DP) - Bottom-up and Top-down DP - Knapsack Problems - Recursion and Memoization - Common DP Patterns - Examples of DP in CP - Divide and Conquer - Binary Search
Unit-IV: Advanced Searching and Graph Techniques
Advanced Searching Algorithms (Ternary Search, Binary Indexed Tree) - Bit Manipulation - Number Theory Algorithms (Sieve of Eratosthenes, Modular Inverse) - Combinatorial in CP - Graph Algorithms (Strongly Connected Components, Topological Sort) - Advanced Topics in Trees (LCA, Diameter)
Unit-V: Dynamic Programming Techniques
Advanced Dynamic Programming Techniques - Bitmask DP - State Compression - Convex Hull DP - Advanced Graph Algorithms - Network Flows (Ford-Fulkerson, Edmonds-Karp) - Minimum Spanning Trees (Kruskal, Prim) - Articulation Points and Bridges - Advanced Data Structures - Persistent Data Structures - Trie and Suffix Trees - Treap and Cartesian Tree - Applications in Competitive Programming - Computational Geometry - Line Sweep Algorithms - Closest Pair of Points - Convex Hull (Graham Scan, Jarvis March)
Text Books:
1. "Competitive Programming" (3rd Edition) by Steven Halim, Felix Halim, 2018 (3rd Edition)
2. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, 2009 (3rd Edition)

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CS655.1	Understand the fundamentals of competitive programming
R19CS655.2	Apply the advanced concepts in stack, queue and tree data structures techniques
R19CS655.3	Apply the advanced algorithmic techniques in data structures
R19CS655.4	Apply the advanced searching and graph data structures techniques
R19CS655.5	Apply the advanced dynamic programming techniques in data structures

R19AM601	Deep Learning Models	L	T	P	C
		3	0	0	3

1. Course Description:

This course covers fundamental machine learning and deep learning concepts, algorithms, and architectures. Topics include learning algorithms, overfitting, hyperparameters, neural networks, CNNs, RNNs, and autoencoders.

2. Course Objectives:

1. Understand the theoretical foundations- algorithms and methodologies of Neural Networks.
2. Apply the concept to design an application using specific deep learning models.
3. To provide the knowledge for analysing real-world applications.

3. Syllabus

UNIT-I: Machine Learning Fundamentals

Learning algorithms, Capacity, Overfitting and Under fitting, Hyper parameters and Validation sets, Maximum likelihood estimation, Bayesian Statistics, Building machine learning algorithm, Feed Forward Neural Networks- Back propagation, Optimizers: Gradient Descent (GD), Stochastic gradient decent.

UNIT-II: Deep Learning Architectures

Introduction- Perceptron Algorithm, Multilayer Perceptron. Activation Functions: RELU, LRELU, ERELU. Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders: Deep Unsupervised Learning, Deep Reinforcement learning, Deep Learning Applications.

UNIT-III: Convolutional Neural Networks

Architectural Overview: Motivation, Pooling, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet, VGG-16, Modern CNN Architecture: Stacked and Hierachical CNN, Dilated CNN, Inception Networks.

UNIT-IV: Sequence Modelling

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures, BPTT for training RNN, Deep Recurrent Networks, and Recursive Neural Networks.

UNIT-V: Autoencoders and Deep Generative Models

Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders, Monte Carlo Methods, Boltzmann Machines, Deep Belief networks, Deep Boltzmann Machine, Generative Adverbial Networks.

Text Books:

1. Kamath, Uday, John Liu, and James Whitaker, "Deep learning for NLP and speech recognition". Vol. 84. Cham: Springer, 2019.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2017.
3. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
4. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer, 2018.

References:
Reference Books:
1. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012. 2. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017. 3. Francois Chollet "Deep Learning with Python", Manning Publications, 2017
MOOC/NPTEL/SWAYAM Course: 1. Deep Learning -https://archive.nptel.ac.in/courses/106/106/106106184/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AM601.1	Design Multi-Layer neural network to solve Supervised Learning problems
R19AM601.2	Apply Regularization methods Early stopping, data augmentation, dropout etc. for optimization results
R19AM601.3	Apply Classical Supervised methods CNN'S, FCN, RCNN etc. for Image Denoising, Segmentation and Object detection problems
R19AM601.4	Use Long Short-Term Memory (LSTM) Networks, GRU for time series analysis classification problems
R19AM601.5	Apply Generative Adversarial Networks, GAN, VAE to solve Supervised and Unsupervised Learning Problems

R19AM602	Video and Speech Analytics	L	T	P	C
		3	0	0	3

1. Course Description:
The course broadly covers the various speech and video processing methodologies. The course enables the students to understand the fundamental concepts of speech analysis and facilitates feature extraction. The course also further teaches the student to track an object in a visual along a boundary for analysis.
2. Course Objectives:
1. To understand the basics of speech signals. 2. To apply the various methodologies for recognizing audio signals. 3. To effectively understand the basics of processing a video. 4. To precisely extract the features through advanced motion detection algorithms. 5. To perform effective detection of boundaries for object tracking.
3. Syllabus
UNIT-I: Speech Processing Concepts
The speech production mechanism, Discrete-time speech signals, Pole-Zero modeling of speech, relevant properties of the fast Fourier transform for speech recognition,

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convolution, linear and nonlinear filter banks, spectral estimation of speech using DFT. Linear Prediction analysis of speech.
UNIT-II: Speech Recognition
Real and Complex Cepstrum, application of cepstral analysis to speech signal, feature extraction for speech, static and dynamic feature for speech recognition, robustness issues, discrimination in the feature space, feature selection, MFCC, LPCC, Distance measures, vector quantization models. Gaussian Mixture model, HMM
UNIT-III: Basics of Video Processing
Video formation, perception and representation: Principle of color video, video cameras, video display, pinhole model, CAHV model, Camera motion, Shape model, motion model, Scene model, two-dimensional motion models. Three-Dimensional Rigid Motion, Approximation of projective mapping.
UNIT-IV: Motion Estimation Techniques
Optical flow, motion representation, motion estimation criteria, optimization methods, pixel-based motion estimation, Block matching algorithm, gradient Based, Intensity matching, feature matching, frequency domain motion estimation, Depth from motion. Motion analysis applications: Video Summarization, video surveillance.
UNIT-V: Object Tracking and Segmentation
2D and 3D video tracking, blob tracking, kernel based counter tracking, feature matching, filtering Mosaicking, video segmentation, mean shift based, active shape model, video shot boundary detection. Interframe compression, Motion compensation.
Text Books: 1. Fundamentals of Speech recognition – L. Rabiner and B. Juang, Prentice Hall signal processing series. 2. Digital Video processing, A Murat Tekalp, Prentice Hall. 3. Discrete-time speech signal processing: principles and practice, Thomas F. Quatieri, Coth. 4. Video Processing and Communications, Yao Wang, J. Osternann and Qin Zhang, Pearson Education.
References:
Reference Books: 1. "Speech and Audio Signal Processing", B.Gold and N. Morgan, Wiley. 2. "Digital image sequence processing, Compression, and analysis", Todd R. Reed, CRC Press. 3. "Handbook of Image and Video Processing", Al Bovik, Academic press, Second Edition.
Journals (Reference): **1.** Middle East Journal of Scientific Research 23:370-376 - Analysis on Video Retrieval Using Speech and Text for Content-Based Information. 2. Applied Sciences - https://www.mdpi.com/2076-3417/14/7/2766.
MOOC/NPTEL/SWAYAM Course: 1. https://archive.nptel.ac.in/courses/117/105/117105145/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome

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R19AM602.1	(Understand) Understand the mechanisms of the human speech production system.
R19AM602.2	(Understand) Understand and learn the various speech recognition methodologies.
R19AM602.3	(Understand) Understand and learn the various video processing mechanisms.
R19AM602.4	(Understand) Explore the various motion estimation techniques.
R19AM602.5	(Apply) Analyze the various methods available for object tracking and boundary detection.

R19AM603	Industrial Machine Learning	L	T	P	C
		3	0	0	3

1. Course Description:

The course helps the students to understand and apply various machine learning algorithms in industrial applications.

2. Course Objectives:

1. Students will be able to describe the fundamental principles of the Fourth Industrial Revolution and summarize its impact on different industry sectors such as Energy, Healthcare, Telecommunications, and Financial Services.
2. Students will evaluate the challenges faced by smart industries in adopting machine learning techniques and identify opportunities for improving industry operations through data-driven solutions.
3. Students will design and construct a Hidden Markov Model-based Remaining Useful Life (RUL) estimation system using feature extraction from vibration signals and interpret the results of the degradation model.

3. Syllabus

Unit-I: Introduction

The Fourth Industrial Revolution: Introduction, Industry Summarization, Machine Learning Challenges and Opportunities within Smart Industries; Applications: Energy Sector, Basic Materials Sector, Industrials Sector, Customer Services Sector, Healthcare Sector, Customer Goods Sector, Telecommunications Sector, Utilities Sector, Financial Services Sector, Information Technology Sector.

Unit-II: Component-Level Case Study

Introduction: Ball Bearing Prognostics: Data, Driven Techniques, PRONOSTIA Testbed, Feature Extraction from Vibration Signals; Hidden Markov Model-Based RUL Estimation: Hidden Markov Model Construction, RUL Results, Interpretation of the Degradation model.

Unit-III: Machine-Level Case Study

Introduction: Performance of Industrial Motors as a Fingerprint, Improving Reliability Models with Fingerprints, Industrial Internet Consortium Testbed, Testbed Dataset Description. Clustering Algorithms for Fingerprint Development: Agglomerative Hierarchical Clustering, K-means Clustering, Spectral Clustering, Affinity Propagation, Gaussian Mixture Model Clustering, and Implementation Details.

Unit-IV: Production-Level Case Study

Introduction: Laser Surface Heat Treatment: Image Acquisition, Response Time Requirement, Anomaly Detection-Based AVI System: Anomaly Detection Algorithms in Image Processing, Proposed Methodology, Performance of the AVI System, Interpretation of the Normality Model.
Unit-V: Distribution-Level Case Study
Introduction: Air Freight Process, Data Preprocessing, Supervised Classification Algorithms for Forecasting: k-Nearest Neighbors, Classification Trees, Rule Induction, Artificial Neural Networks, Support Vector Machines, Logistic Regression, Bayesian Network Classifiers, Meta classifiers, Implementation.
Text Book:
1. Pedro Larranaga, David Atienza,Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, "Industrial Applications of Machine Learning", 1st Edition, CRC Press, 2019 .
References:
Reference Book: 1. Andreas François Vermeulen," Industrial Machine Learning: Using Artificial Intelligence as a Transformational Disruptor", 1 st Edition, Apress, 2020.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AM603.1	Understand the concepts and implications of the Fourth Industrial Revolution across various industrial sectors.
R19AM603.2	Analyze machine learning challenges and opportunities within smart industries
R19AM603.3	Develop and implement component-level prognostics for industrial applications using data-driven techniques.
R19AM603.4	Evaluate the performance of industrial motors using clustering algorithms to develop reliability models.
R19AM603.5	Implement supervised classification algorithms for forecasting in air freight processes.

R19AM604	**Machine Learning for Smart Cities**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description:					
This course provides working principles of Sensors, UAVs, Geriatric Design and IoT Enabled Homes and applying machine learning for Smart Cities					
2. Course Objectives:					
1. To understand the role of machine learning in creating sustainable and resilient buildings.					

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2. To explore the use of sensors and UAVs in monitoring and managing smart environments.
3. To analyze data fusion approaches for enhancing smart city infrastructure.

3. Syllabus

Unit-I: Machine Learning for Sustainable and Resilient Buildings

Introduction, Sustainability and Resiliency Conditions, Paradigm and challenges of Sustainability and Resilience, Sustainability and Resilience of Engineered System, Structure Engineering Dilemmas and Resilient Epcot, Smart Building Appliances Intelligent Tools (SRB), Component of Smart Buildings, Machine Learning Tasks, ML Tools and Services, Big Data Application in SB.

Unit-II: Sensors and UAVs

Introduction, Sensors, Unmanned Aerial Vehicle, Bluetooth, Problem Description, Univariate Time series, Multivariate Time Series, Hidden Markov Model, Fuzzy Logic.

Unit-III: Data Fusion Approaches

Introduction to Data Fusion, Types of Data Fusion Architecture, Centralized Architecture, Decentralized Architecture, Distributed Architecture, Hierarchical Architecture, Case Study: Smart City Infrastructure, IoT Deployments, Smart City Control and Management Centers, Theory of Unified City Modeling, Smart City Operational Model. Theories and Models: Case Study: Web Browsing History Analysis, Data Model for Group Construction in Student's Industrial Placement.

Unit-IV: Geriatric Design and IoT Enabled Smart Homes

Introduction to Geriatric Design: Background. Development of Smart Homes. Development of Smart Homes for Elderly, Indian Scenario, Geriatric Smart Home Requirements, Design, Framework for Smart homes, Architectural Interventions. Case Study: Schematic Design for a Nesting Home, IoT Based Real Time Automation, Technical Components of Smart Home.

Unit-V: Impact of IoT Enabled Smart Cities

Recent Developments in IoT Applications for Modern City, Classification of IoT based Smart Cities, Impact of 5G Technology, IoT Five Layer Architecture, IoT Computing Paradigm, Research Advancement and Drawbacks, Integration of Cloud Computing, integration of Applications, System Security, Research Challenges and Guidelines.

Text Book:

4. Adarsh Kumar, Anand Nayyar, Arun Solanki, "Digital Cities Road map IoT-Based Architecture and Sustainable Buildings", 1st Edition, Wiley, 2021.

References:

Reference Book:

4. J. Joshua Thomas, Vasiliki Geropanta, Anna Karagianni, Vladimir Panchenko, "Smart Cities and Machine Learning in Urban Health", 1st Edition, IGI Global, US, 2021.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19AM604.1	Interpret the machine learning concepts for sustainable and resilient buildings
R19AM604.2	Demonstrate the concept of sensors and time series data

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R19AM604.3	Explore Data fusion approach vectors and trends
R19AM604.4	Develop Geriatric design on IoT enabled homes
R19AM604.5	Study the impact of IoT enabled smart cities

R19EC601	Discrete Time Signal Processing	L	T	P	C
		3	0	0	3

1. Course Description:

This course explores the fundamentals of discrete-time signal processing, focusing on the analysis and manipulation of digital signals. Students will learn techniques for sampling, filtering, and transforming signals using various algorithms. Practical applications and tools will be emphasized, equipping learners with skills for real-world signal processing challenges.

2. Course Objectives:

1. To learn discrete fourier transform, properties of DFT and its application to linear filtering
2. To understand the characteristics of digital filters, design digital IIR and FIR filters and apply these filters to filter undesirable signals in various frequency bands
3. To understand the effects of finite precision representation on digital filters
4. To understand the fundamental concepts of multi rate signal processing and its applications
5. To introduce the concepts of adaptive filters and its application to communication engineering

3. Syllabus:

Unit-I: Discrete Fourier Transform

Review of signals and systems, concept of frequency in discrete-time signals, summary of analysis & synthesis equations for FT & DTFT, frequency domain sampling, Discrete Fourier transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT). Linear filtering using FFT.

Unit-II: Infinite Impulse Response Filters

Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

Unit-III: Finite Impulse Response Filters

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Design of FIR filters - symmetric and Anti-symmetric FIR filters - design of linear phase FIR filters using Fourier series method - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations.

Unit-IV: Finite Word Length Effects

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

Unit-V: Introduction to Digital Signal Processors

DSP functionalities - circular buffering – DSP architecture – Fixed and Floating point architecture principles – Programming – Application examples.

Text Book:

1. John G. Proakis & Dimitris G.Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.

Reference Books:

1. Emmanuel C. Ifeachor & Barrie. W. Jervis, —Digital Signal Processing‖, Second Edition, Pearson Education / Prentice Hall, 2002.
2. A. V. Oppenheim, R.W. Schafer and J.R. Buck, —Discrete-Time Signal Processing‖, 8th Indian Reprint, Pearson, 2004.
3. Sanjit K. Mitra, —Digital Signal Processing – A Computer Based Approach‖, Tata Mc Graw Hill, 2007.
4. Andreas Antoniou, —Digital Signal Processing‖, Tata Mc Graw Hill, 2006..

Journals:

1. https://www.sciencedirect.com/journal/signalprocessing-journal
2. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=92

Video References:

1. https://www.youtube.com/watch?v=oZSv68esbgI
2. https://www.youtube.com/watch?v=4cPkr1VHu7Q

MOOC/NPTEL/SWAYAM Course:

1. https://www.udemy.com/course/digital-signal-processing

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC601.1	Illustrate the concepts of Discrete Fourier Transform and its properties
R19EC601.2	Learn the design and characteristics of infinite impulse response (IIR) filters for filtering undesired signals
R19EC601.3	Learn the design and characteristics of finite impulse response (FIR) filters for filtering undesired signals
R19EC601.4	Explain the concepts of finite word length effects
R19EC601.5	Assess various applications in Multi-rate signal processing using various DSP processors

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R19EC602	Principles of Analog and Digital Communication	L	T	P	C
		3	0	0	3

1. Course Description:

This course aims at designing Analog and Digital Communication Systems that are used for transmission of information from the source to the destination. A detailed framework for analog and digital communication techniques are addressed. The purpose of this course is to give hands on training to the students in understanding the theory of communication and practicing sessions used in analog and digital communication systems. This will enhance the understanding capability of the students.

2. Course Objectives:

1. To analyze the principles and characteristics of various analog communication techniques.
2. To describe the operation and components of data communication systems, including pulse modulation techniques.
3. To apply knowledge of digital communication techniques.
4. To design and implement error control coding schemes.
5. To understand and utilize techniques for multi-user radio communication.

3. Syllabus:

Unit-I: Analog Communication

Introduction to Communication Systems – Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems.

Unit-II: Data and Pulse Communication

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System, Data Communication: History of Data Communication – Standards, Organizations for Data Communication- Data Communication Circuits.

Unit-III: Digital Modulation

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM - Bandwidth Efficiency– Comparison of various Digital Communication System

Unit-IV: Source and Error Control Coding

Entropy, Source Encoding Theorem, Shannon Fano Coding, Huffman Coding, Mutual Information, Channel Capacity, Error Control Coding, Linear Block Codes, Cyclic Codes – ARQ Techniques.

Unit-V: Multi-user Radio Communication

Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA) – Cellular Concept and Frequency Reuse – Channel Assignment and Handover Techniques – Overview of Multiple Access Schemes – Satellite Communication – Bluetooth.

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Text Books:

1. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2019.
2. B.P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.

Reference Books:

1. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2004
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education,2007
3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.
4. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.

Journals:

1. https://www.sciencedirect.com/journal/microelectronics-journal
2. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=92

Video References:

1. https://www.youtube.com/watch?v=oZSv68esbgI
2. https://www.youtube.com/watch?v=4cPkr1VHu7Q

MOOC/NPTEL/SWAYAM Courses:

1. https://www.udemy.com/course/asic-bootcamp-sta-basic-concepts
2. https://www.coursera.org/learn/vlsi-cad-layout

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC602.1	Analyze the principles and characteristics of various analog communication techniques, such as AM and FM.
R19EC602.2	Describe the operation and components of data communication systems like PWM and PPM.
R19EC602.3	Understand digital communication techniques, such as ASK, PSK, and FSK.
R19EC602.4	Design and implement error control coding schemes to ensure reliable communication in digital systems.
R19EC602.5	Understand and utilize techniques for multi-user radio communication including TDMA and CDMA.

R19EC603	Digital Systems and VLSI Design	L	T	P	C
		3	0	0	3

1. Course Description:

This course introduces digital systems and integrated circuit design concepts and techniques, focusing on CMOS logic for digital design. Students learn to analyze circuit performance and verify functionality and timing constraints.

2. Course Objectives:

1. To understand the basics of the number system and minimization techniques
2. To understand the design of combinational and sequential logic circuits

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3. To introduce the basic concepts and techniques of modern integrated circuit design.
4. Describe the fundamental principles underlying digital design using CMOS logic
5. Analyze the performance characteristics of these digital circuits

3. Syllabus:

Unit-I: Introduction of Basics concepts of Digital System

Review of Number systems - Logic gates - Boolean algebra: Boolean postulates and laws - De-Morgan's Theorem - Principle of Duality - Simplification using Boolean algebra - Canonical forms - Sum of product and Product of sum -Minimization using Karnaugh map - NAND and NOR implementation.

Unit-II: Combinational Logic Circuits

Combinational Logic: Design Procedure – Adders – Subtractors - Magnitude Comparator - Code converters– decoder - encoder – Multiplexer and Demultiplexer - parity generator – parity checker.

Unit-III: Sequential Logic Circuits

Flip flops – SR, D, JK, T – Realization of one flip flop using other flip flops, Analysis and design of clocked sequential circuits - Design of Counters, shift registers, Shift register counters - Moore/Mealy models, state minimization, state assignment.

Unit-IV: MOS Transistor Theory

MOS transistors; Long Channel I-V Characteristics; C-V Characteristics; Non-ideal I-V effects; Fabrication process; Layout Design Rules: MOSIS scalable CMOS design rules, Micron design rules; Stick diagrams.

Unit-V: CMOS Performance Analysis

CMOS logic: The Inverter, NAND gate, NOR gate, Pass transistors, Transmission gates; CMOS Inverter - DC transfer characteristics, Transistor sizing, Noise Margin; Transient response; RC delay model; Linear delay model; Logical effort of paths; Timing analysis of delay models,

Text Books:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", 5th Edition, Pearson, 2014.
2. Neil H.Weste, Harris, A. Banerjee, CMOS VLSI Design, A circuits and System Perspective, 2015, 4th Edition, Pearson Education.
3. Wayne Wolf, "FPGA-Based System Design", First Edition, Prentice Hall India Private Limited, 2004.

Reference Books:

1. Thomas L.Floyd, "Digital Fundamentals", Prentice Hall, 11th Edition, 2015.
2. Jan M. Rabaey, Anantha Chadrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective Paperback, 2016, 2rd Edition, Pearson Education, India.
3. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Reprint 2009.
4. Douglas A. Pucknell, "Basic VLSI Systems and Circuits", Prentice Hall of India, 3rd Edition, reprint2008.

Journals:

1. https://www.sciencedirect.com/journal/microelectronics-journal

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2. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=92

Video References:

1. https://www.youtube.com/watch?v=oZSv68esbgI
2. https://www.youtube.com/watch?v=4cPkr1VHu7Q

MOOC/NPTEL/SWAYAM Courses:

1. https://www.udemy.com/course/asic-bootcamp-sta-basic-concepts
2. https://www.coursera.org/learn/vlsi-cad-layout

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC603.1	Apply Boolean algebra, Karnaugh map to design combinational logic circuits
R19EC603.2	Apply different minimization techniques for designing various combinational logic circuits
R19EC603.3	Outline and design the synchronous sequential digital circuits for real time applications
R19EC603.4	Understand MOS transistor fundamentals. CMOS logic and layout design principles.
R19EC603.5	Analyze the characteristics of CMOS inverter and various delay models

R19EC604	**Introduction to IoT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

Comprehensive Internet of Things (IoT) coursework will allow you to investigate this revolutionary field. Learn about embedded systems, communication protocols, cloud computing, privacy protection, and new IoT applications. Get hands-on experience and insights into the technologies transforming the digital landscape of interconnected gadgets and intelligent systems.

2. Course Objectives:

1. To understand the core components of embedded systems and their role in IoT devices.
2. To explore cloud-based services and tools for data visualization, analytics, and other applications in IoT.
3. To analyze various communication protocols used in IoT networks (e.g., Wi-Fi, Bluetooth, cellular) and their suitability for different applications.
4. To analyze the security vulnerabilities and privacy risks associated with data collection, transmission, and storage in IoT deployments.
5. To analyze the privacy risks associated with data collection, transmission, and storage in IoT deployments.

3. Syllabus

Unit-I: Overview of IoT

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Introduction to IoT: hardware architecture, software architecture, Characteristics of IoT, Challenges, applications; Impact of IoT on business and society; IoT product development life cycle; Network Layers

Unit-II: Communication Protocols and Hardware's for IoT

Communication modules: BLE, WiFi, IoT Protocols: IPv6, CoAP, MQTT; Wired Communication, Launch Pads Overview: Arduino/ESP 32, AT Tiny; Hardware for IoT:Sensors, Actuators, RFID technology; Power Sources.

Unit-III: Cloud Computing for IoT

Cloud Enabling Technologies, Characteristics and benefits of Cloud Computing, Cloud Service Models, Cloud computing Infrastructure, Cloud Challenges, Server Types within IaaS solutions, Cloud-based data storage, Cloud-based backup devices.

Unit-IV: Privacy Protection and Trust Models for IoT

One-Time Mask Scheme, Mobile Wireless Body Sensor Network, Trust Model Concepts, Public Key Infrastructures Architecture Components, Public Key Certificate Formats, Design Considerations for Digital Certificates, Authentication in IoT, and Computational Security for IoT.

Unit-V: IoT Applications for Value Creations

Introduction, IoT applications for industry: Brownfield IoT, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Applications and Value for Industry, Home Management, eHealth.

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2015.
2. Hu, Fei. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, 2016, 1st edition, CRC Press, USA.

Reference Books:

1. Bahga, Arshdeep, and Vijay Madisetti, Cloud computing: A hands-on approach, 2014,2ndedition, CreateSpace Independent Publishing Platform, USA.
2. Anthony T. Velte Toby J. Velte, "Cloud Computing: A Practical Approach" MGH, 2010.
3. Rajkumar Buyya,Amir Vahid " Internet of Things Principles and Paradigms", Elsevier, 2016.
4. Neil Cameron, "Arduino Applied: Comprehensive Projects for Everyday Electronics", A Press, 2019

Journals:

1. Kumar, S., Tiwari, P. &Zymbler, M. Internet of Things is a revolutionary approach for future technology enhancement: a review. J Big Data 6, 111 (2019). https://doi.org/10.1186/s40537-019-0268-2

2. V. -V. Vo, D. -T. Le, S. M. Raza, M. Kim and H. Choo, "Active Neighbor Exploitation for Fast Data Aggregation in IoT Sensor Networks," in IEEE Internet of Things Journal, vol. 11, no. 8, pp. 13199-13216, 15 April15, 2024, doi: 10.1109/JIOT.2024.3354730.

Video Reference:

...war College of Engineering (Auto...
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1.https://www.youtube.com/playlist?list=PLEiEAq2VkUUImmTXP_YC2j5qIGOV9NPLy **MOOC/NPTEL /SWAYAM Course:** 1. Introduction To Internet of Things, By Prof. Sudip Misra, IITKharagpurhttps://onlinecourses.nptel.ac.in/noc24_cs35/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC604.1	Explain the fundamentals of an embedded system, networking, and its applications.
R19EC604.2	Apply the appropriate communication protocol based on the requirements of an IoT application.
R19EC604.3	Analyze the cloud computing models and apply them based on the applications.
R19EC604.4	Analyze the importance of privacy protection in IoT ecosystems, considering legal, ethical, and societal implications.
R19EC604.5	Develop IoT solutions that address specific challenges in various real-time applications

R19EC605	Basics of Biomedical Instrumentation	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides an in-depth exploration of Medical Electronics, focusing on essential topics crucial to understanding healthcare technology. Students will delve into the principles of bio-potential signals generated by the human body and learn techniques for their recording and analysis. The design, operation, and application of transducers converting biological signals into electrical signals suitable for processing and measurement. Students will study the integration of transducers with recording systems, including signal conditioning, amplification, and digitization techniques. The course explores various types of biomedical recorders used in clinical settings, emphasizing their functionalities, data storage, and retrieval mechanisms. Students will analyze safety considerations in medical electronics, focusing on equipment design, regulatory standards, and risk management.

2. Course Objectives:

1. Grasp the fundamental concepts related to bio-electric potential, including its generation and measurement techniques.
2. Gain knowledge about various types of physiological transducers, their principles of operation, and their applications in healthcare and research.
3. Learn the engineering principles behind recording systems used to capture bio-electric signals and other physical parameters.
4. Apply their understanding of basic sciences to effectively record bio-electric potentials from living organisms.

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5. Recognize different shock hazards associated with electrical equipment in clinical environments and take preventive measures to ensure safety.
3. Syllabus:
Unit-I: Electro-Physiology and Bio-Potential Recording
Sources of bioelectric potential – Resting and Action potential – Propagation of action potential, Bioelectric Potentials- ECG, EEG and EMG, Electrode theory, Bio-potential electrodes and Biochemical transducers
Unit-II: Physiological Transducers
Classification of Transducers- Static and Dynamic Characteristics of Transducers – Potentiometric Transducer- LVDT- Strain Gauge Pressure Transducer, Thermistors, Photoelectric Transducer- Barrier layer cells, Photo emissive Cells, Fibre Optic Sensors – Physical Sensors - Chemical Sensors.
Unit-III: Recording System
Basic Recording System, Basic of Preamplifiers, Bio-potential Amplifier, Instrumentation amplifier, Chopper amplifier, Isolation amplifier, Direct writing galvanometric recorder, Thermal Array Recorders.
Unit-IV: Biomedical Recorders
Electrocardiograph (ECG), Phonocardiograph (PCG), Electroencephalograph (EEG), Electromyography (EMG)
Unit-V: Patient Safety Equipment
Electric shock hazards – Leakage current – Safety Codes for Electromedical Equipment – Electrical Safety Analyser – Testing of Biomedical Equipment
Text Books:
1. Khandpur. R.S., "Handbook of Biomedical Instrumentation", TATA McGraw Hill, NewDelhi,3rd Edition, 2014. 2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical instrumentation and measurement", 2nd Edition, Pearson Education, New Delhi, 2001
Reference Books: 1. John G.Webster, "Medical Instrumentation Application and Design", Fourth Edition, John Wiley &Sons,Singapore, 2010. 2. Joseph J. Carrand John M. Brown, "Introduction to Biomedical equipment Technology", Pearson Education, New Delhi, Fourth Edition Indian Reprint, 2004. 3. Arther C Guyton, John E. Hall, "Textbook of Medical Physiology", 12th Edition, Elsevier Publication, 2016. **Journals:** 1. Mendes, P.M., Figueiredo, C.P., Fernandes, M., Gama, Ó.S. (2011). Electronics in Medicine. In: Kramme, R., Hoffmann, KP., Pozos, R.S. (eds) Springer Handbook of Medical Technology. Springer Handbooks. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-74658-4_74. **Video References:**

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Kinathukadavu, Coimbatore - 641 202.

1. https://www.youtube.com/watch?v=uSKv-b0Fe_A
2. https://www.youtube.com/watch?v=iK6q4nnmtA&list=PLVsrfTSlZ_42OoOyhzWoDgZrL9iineZxQ
3. https://www.youtube.com/watch?v=FaHK9oO8ink
4. https://www.youtube.com/watch?v=QzZh243-Ac8
5. https://www.youtube.com/watch?v=Ir5Y1g55WBw

MOOC/NPTEL/ SWAYAM Course:

1. https://onlinecourses.swayam2.ac.in/nou23_bt05/preview

4. Course Outcomes

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC605.1	Understand the concepts of bio-electric potential and bio potential measurements
R19EC605.2	Understand the working of different types of Physiological Transducers
R19EC605.3	Understand the basic engineering concept of recording system on physical parameters
R19EC605.4	Apply the knowledge of basic sciences to record bio-electric potential
R19EC605.5	Identify the different shock hazards to prevent electrical accidents in clinical environment

R19EC606	Introduction to Image Processing	L	T	P	C
		3	0	0	3

1. Course Description:

This course introduces the steps and components of image processing, how digital images are acquired, sampled, quantized and the relationship between pixels. In image enhancement and restoration both spatial and frequency domain techniques are utilized. Segmentation techniques explained with edge detection and morphological processing. This course addresses the compression techniques and standards for efficient storage. It also deals with the techniques to extract features for image representation and recognition

2. Course Objectives:

1. To introduce the Basic concepts and analytical methods of analysis of digital images.
2. To study fundamental concepts of Digital Image Processing and basic relations among pixels
3. To study different spatial and frequency domain concepts.
4. To understand restoration process of degraded image and Multi resolution processing.
5. To understand image compression and Segmentation Techniques.

3. Syllabus:

Unit-I: Image Fundamentals

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Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some basic Relationships between Pixels. Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System.

Unit-II: Image Enhancement

Some Basic Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, smoothing spatial Filters, Sharpening spatial Filters. Introduction to the Fourier Transform and the Frequency Domain, smoothing frequency-domain Filters, Sharpening Frequency-domain Filters, Homomorphic Filtering, Implementation

Unit-III: Image Restoration

A Model of the Image Degradation/Restoration Process, Linear, Position Invariant Degradations, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. Wavelets and Multi resolution Processing

Unit-IV: Image Segmentation and Compression

Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Based Segmentation. Image Compression Models, Error-free Compression, Lossy Compression, Image Compression Standards.

Unit-V: Representation and Description

Boundary representation, Chain Code, Polygonal approximation, signature, boundary Segments, Boundary description, Shape number, Fourier Descriptor, moments, Regional Descriptors, Topological feature, Texture, Patterns and Pattern classes, Recognition based on matching.

Text Books:

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
2. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.

Reference Books:

1. Jayaraman, S., Esakkirajan, S., &Veerakumar, T. (2009). Digital image processing (Vol. 7014) New Delhi: Tata McGraw Hill Education.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
3. Willliam K Pratt, "Digital Image Processing", John Willey, 2002.

Journals:

1. Journal of Real-Time Image Processing
2. Computer Vision, Graphics, and Image Processing
3. IET Image Processing

Video Reference:

1. https://www.youtube.com/watch?v=CVV0TvNK6pk

MOOC/NPTEL/SWAYAM Course:

1. https://archive.nptel.ac.in/courses/117/105/117105135/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC606.1	Discuss digital image fundamentals
R19EC606.2	Articulate image enhancement and restoration techniques
R19EC606.3	Examining image compression Techniques
R19EC606.4	Implementing image segmentation Techniques
R19EC606.5	Representation and recognition of images

R19EC607	**Microcontroller and Embedded Systems**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course introduces the steps and components of image processing, how digital images are acquired, sampled, quantized and the relationship between pixels. In image enhancement and restoration both spatial and frequency domain techniques are utilized. Segmentation techniques explained with edge detection and morphological processing. This course addresses the compression techniques and standards for efficient storage. It also deals with the techniques to extract features for image representation and recognition

2. Course Objectives:

1. To study about the architecture and programming of 8051 microcontroller
2. To study the design techniques of peripheral ICs with microcontroller
3. To study the basic functions and programming of 8051 microcontroller
4. To study about the fundamentals of embedded system design
5. To learn about embedded system architecture

3. Syllabus:

Unit-I: Introduction to Microcontroller

Introduction to 8-bit microcontroller: 8051 architecture, memory organization, special function registers – port operation – timer/counters – serial interface – interrupts – operand addressing – instruction set – programming.

Unit-II: Interfacing 8051Microcontroller

Programming 8051 Timers; Serial Port Programming; Interrupts Programming; Interfacing: LCD, Keyboard, ADC, DAC, Sensor, External Memory, Stepper Motor; Waveform generation.

Unit-III: Embedded System Architecture

Introduction to Embedded system – application areas – categories – overview – specialties – recent trends – hardware architecture – software architecture – application software – communication software – process of generating executable image – developing and testing tools.

Unit-IV: Embedded System Development

Development process – requirements engineering – design – implementation – integration and testing – Architecture of Kernel - Tasks and task scheduler – Interrupt service routines – semaphores – mailboxes – timers – memory management – priority inversion problem.

Unit-V: Embedded Hardware Platforms

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RISC Vs CISC Architecture; Introduction to Arduino Uno; Switches: Tactile switch; Sensors: Temperature, LDR, PIR; LCD Display; Bluetooth Communication: BT terminal HC-05 app; Wi-Fi Communication: NodeMCU ESP8266; Introduction to Raspberry pi.
Text Books:
1. Krishna Kant, "Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096", PHI, 2013. 2. Dr.K.V.K.K. Prasad, "Embedded/Real-time Systems: Concepts, Design and Programming", Dreamtech Press, 2012.
Reference Books: 1. A.K. Ray and K.M. Bhurchandi, "Advanced Microprocessor and Peripherals", MGH, 3/e, 2017 2. Mohammed Ali Mazidi, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson, 2/e, 2012 3. Wayne wolf, "Computers as Components: Principles of Embedded Computing System design", 4/e, M.K. Publishers, 2013 **Journals:** 1. Journal of Real-Time Embedded Systems 2. Microprocessors and Microcontrollers Video Reference: 1. https://www.youtube.com/watch?v=CVV0TvNK6pk **MOOC/NPTEL/SWAYAM Course:** 1. https://archive.nptel.ac.in/courses/microcontrollers/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC607.1	Analyze the architecture of the 8051-microcontroller .
R19EC607.2	Demonstrate comprehension of the 8051-microcontroller architecture by developing an assembly program using 8051 instructions
R19EC607.3	Outline the programming model and interfacing peripheral devices with 8051 microcontroller
R19EC607.4	Applying the knowledge of tasks and task scheduling of embedded system architecture and design process
R19EC607.5	Evaluate microcontrollers-based systems using Sensor and Communication devices

R19EC608	**Wireless Sensor Networks**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description:					
This course provides an in-depth exploration of Wireless Sensor Networks (WSNs), focusing on their architecture, protocols, and applications. Students will gain insights into medium access control, routing strategies, and embedded operating systems tailored for WSNs. Practical applications across various fields, including industrial and environmental monitoring, will be highlighted.					
2. Course Objectives:					

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1. Understand the characteristics and challenges specific to wireless sensor networks.
2. Explore and analyze various medium access control protocols used in WSNs.
3. Investigate routing protocols and data gathering techniques in sensor networks.
4. Examine embedded operating systems designed for sensor nodes and their programming.
5. Identify and evaluate real-world applications of WSNs across diverse sectors.

3. Syllabus:

Unit-I: Characteristics of WSN

Characteristic requirements for WSN - Challenges for WSNs – WSN vs Adhoc Networks - Sensor node architecture – Commercially available sensor nodes –Imote, IRIS, Mica Mote, EYES nodes, BTnodes, TelosB, Sunspot -Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.

Unit-II: Medium Access Control Protocols

Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts – Contention based protocols - Schedule-based protocols - SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA) - The IEEE 802.15.4 MAC protocol.

Unit-III: Routing and Data Gathering Protocols

Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping – Data centric Routing – SPIN – Directed Diffusion – Energy aware routing - Gradient-based routing - Rumor Routing – COUGAR – ACQUIRE – Hierarchical Routing - LEACH, PEGASIS – Location Based Routing – GF, GAF, GEAR, GPSR – Real Time routing Protocols – TEEN, APTEEN, SPEED, RAP - Data aggregation - data aggregation operations - Aggregate Queries in Sensor Networks - Aggregation Techniques – TAG, Tiny DB.

Unit-IV: Embedded Operating Systems

Operating Systems for Wireless Sensor Networks – Introduction - Operating System Design Issues - Examples of Operating Systems – TinyOS – Mate – MagnetOS – MANTIS - OSPM - EYES OS – SenOS – EMERALDS – PicOS – Introduction to Tiny OS – NesC – Interfaces and Modules- Configurations and Wiring - Generic Components -Programming in Tiny OS using NesC, Emulator TOSSIM.

Unit-V: Applications of WSN

WSN Applications - Home Control – Building Automation - Industrial Automation - Medical Applications - Reconfigurable Sensor Networks - Highway Monitoring - Military Applications - Civil and Environmental Engineering Applications - Wildfire Instrumentation - Habitat Monitoring - Nanoscopic Sensor Applications – Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling

Text Books:

1.Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications ", John Wiley & Sons, 2007.
2.Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.

Reference Books:

1. K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325--349
2. Philip Levis, " TinyOS Programming"
3. Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd,

Journals:

1. Journal of Sensor and Actuator Networks
2. IEEE Transactions on Wireless Communications

Video References:

1. https://www.youtube.com/watch?v=2b7wU0U9tW4
2. https://www.youtube.com/watch?v=xq2EDWJYyOQ

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1. NPTEL Wireless Sensor Networks Course

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC608.1	Analyze the fundamental characteristics and requirements of wireless sensor networks.
R19EC608.2	Design and implement medium access control protocols suitable for WSNs.
R19EC608.3	Evaluate routing strategies and data aggregation techniques for effective communication.
R19EC608.4	Develop applications using embedded operating systems and programming languages specific to WSNs.
R19EC608.5	Assess the impact and potential of WSNs in various practical applications and industries.

R19EC609	Introduction to Robotics and Automation	L	T	P	C
		3	0	0	3

1. Course Description:

This course offers a comprehensive overview of robotics, covering the history, types, and drive systems of robots. Students will explore sensing and control methods, as well as computer interfaces and maintenance practices. The curriculum emphasizes practical applications of robots in various industries and their future impact on society.

2. Course Objectives:

1. Understand the fundamental concepts and history of robotics and their evolution.
2. Explore various drive systems and end effectors used in robotic applications.
3. Analyze sensing technologies and control methods for effective robot programming.
4. Learn about robot-computer interfaces and the importance of maintenance practices.
5. Evaluate the diverse applications of robots in manufacturing and their societal implications.

3. Syllabus:

Unit-I: Robot - Introduction

Robot history - Computer programs – Microprocessors - Positive aspects of robots - Robots versus humans - Types of robots – Manipulator - Degrees of freedom – Coordinates - Moving the manipulator.

Unit-II: Drive Systems

Hydraulics, Pneumatics, Electric – End effectors – Positioning – Repeatability and accuracy – Drives, Harmonic drives – Belts – Chains.

Unit-III: Sensing and Control Methods
Sensing: Classes of sensors – Sensor: Proximity, range, tactile - Control methods: Electric power, Servo controlled, Non-servo controlled – Actuators - Controllers – Programming a robot.
Unit-IV: Computer Interface and Maintenance
Robot-computer interface – Languages - Interfacing - Interfacing robot and computer - Program control - Vision for the robot – Maintenance: Preventive maintenance - Maintenance of small electric motors - Using meters to check for problems.
Unit-V: Uses for Robots
Loading and Unloading - Materials Handling - Fabricating - Assembling - Painting - Welding - Inspecting and Testing - The Future of Flexible Automation - The Future of Robots - Social Impact of Robots.
Text Book:
1. Mark R. Miller and Rex Miller, "Robots and Robotics: Principles, Systems, and Industrial Applications", 1/e, 2017
Reference Books: 1. Mordechai Ben-Ari and Francesco Mondada, "Elements of Robotics", Springer, 2017 2. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, "Industrial Robotics, Technology programming and Applications", McGraw Hill, 2012. **Journals:** 1. IEEE Transactions on Robotics and Automation 2. Robotics and Autonomous Systems **Video References:** 1. https://www.youtube.com/watch?v=6A9TAX2BZ_U 2. https://www.youtube.com/watch?v=7Vg2fW7Tz1M **MOOC/NPTEL/SWAYAM Course:** 1. Introduction to Robotics: NPTEL Robotics Course

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC609.1	Describe the historical development and types of robots used in various applications.
R19EC609.2	Analyze different drive systems and their role in robotic functionality.
R19EC609.3	Identify and apply various sensors and control methods in robot programming.
R19EC609.4	Implement effective robot-computer interfaces and understand maintenance techniques.
R19EC609.5	Assess the applications of robots in industries and their broader social impact.

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R19EC610	Medical Electronics	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides an in-depth exploration of Medical Electronics, focusing on essential topics crucial to understanding healthcare technology. Students will delve into the principles of bio-potential signals generated by the human body and learn techniques for their recording and analysis. The design, operation, and application of transducers converting biological signals into electrical signals suitable for processing and measurement. Students will study the integration of transducers with recording systems, including signal conditioning, amplification, and digitization techniques. The course explores various types of biomedical recorders used in clinical settings, emphasizing their functionalities, data storage, and retrieval mechanisms. Students will analyze safety considerations in medical electronics, focusing on equipment design, regulatory standards, and risk management.

2. Course Objectives:

1. Understand the concepts of bio-electric potential and bio potential measurements
2. Understand the working of different types of Physiological Transducers
3. Understand the basic engineering concept of recording system on physical parameters
4. Apply the knowledge of basic sciences to record bio-electric potential
5. Identify the different shock hazards to prevent electrical accidents in clinical environment

3. Syllabus:

Unit-I: Electro-Physiology and Bio-Potential Recording

Sources of bioelectric potential – Resting and Action potential – Propagation of action potential, Bioelectric Potentials- ECG, EEG and EMG, Electrode theory, Bio-potential electrodes and Biochemical transducers

Unit-II: Physiological Transducers

Classification of Transducers- Static and Dynamic Characteristics of Transducers – Potentiometric Transducer- LVDT- Strain Gauge Pressure Transducer, Thermistors, Photoelectric Transducer- Barrier layer cells, Photoemissive Cells, Fibre Optic Sensors – Physical Sensors - Chemical Sensors.

Unit-III: Recording System

Basic Recording System, Basic of Preamplifiers, Bio-potential Amplifier, Instrumentation amplifier, Chopper amplifier, Isolation amplifier, Direct writing galvanometric recorder, Thermal Array Recorders.

Unit-IV: Biomedical Recorders

Electrocardiograph (ECG), Phonocardiograph (PCG), Electroencephalograph (EEG), Electromyography (EMG)

Unit-V: Patient Safety Equipment

Electric shock hazards – Leakage current – Safety Codes for Electromedical Equipment – Electrical Safety Analyser – Testing of Biomedical Equipment

Text Books:

1. Khandpur. R.S., "Handbook of Biomedical Instrumentation", TATA McGraw Hill, New Delhi,3rd Edition, 2014.

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2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical instrumentation and measurement", 2nd Edition, Pearson Education, New Delhi, 2001

Reference Books:

1. John G.Webster, "Medical Instrumentation Application and Design", Fourth Edition, John Wiley &Sons,Singapore, 2010.
2. Joseph J. Carrand John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, New Delhi, Fourth Edition Indian Reprint, 2004.
3. Arther C Guyton, John E. Hall, "Textbook of Medical Physiology", 12th Edition, Elsevier Publication, 2016.

Journal:

1. Mendes, P.M., Figueiredo, C.P., Fernandes, M., Gama, Ó.S. (2011). Electronics in Medicine. In: Kramme, R., Hoffmann, KP., Pozos, R.S. (eds) Springer Handbook of Medical Technology. Springer Handbooks. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-74658-4_74.

Video References:

1. https://www.youtube.com/watch?v=uSKv-b0Fe_A
2. https://www.youtube.com/watch?v=iK6q4nnmtA&list=PLVsrfTSlZ_42OoOyhzWoDgZrL9iineZxQ
3. https://www.youtube.com/watch?v=FaHK9oO8ink
4. https://www.youtube.com/watch?v=QzZh243-Ac8
5. https://www.youtube.com/watch?v=Ir5Y1g55WBw

MOOC/NPTEL/UDEMY Course:

1. https://onlinecourses.swayam2.ac.in/nou23_bt05/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EC610.1	Understand the concepts of bio-electric potential and bio potential measurements
R19EC610.2	Understand the working of different types of Physiological Transducers
R19EC610.3	Understand the basic engineering concept of recording system on physical parameters
R19EC610.4	Apply the knowledge of basic sciences to record bio-electric potential
R19EC610.5	Identify the different shock hazards to prevent electrical accidents in clinical environment

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R19EE601	Solid State Electronics	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive introduction to the field of power electronics, which deals with the control and conversion of electric power. You will gain a solid understanding of the underlying principles, analysis techniques, design considerations, and applications of power electronic circuits.

2. Course Objectives:

1. To impart knowledge on the power semiconductor switches used for the design of various power electronic converters.
2. To equip students with a comprehensive understanding of phase-controlled converters and their applications.
3. To facilitate the students to gain insights on DC-to-DC converters, their types, operation and applications.
4. To provide knowledge on the operation of DC to AC converters and their applications.
5. To give exposure on the different types of AC to AC converters.

3. Syllabus

Unit – I: Power Semiconductor Devices

Introduction; Scope and Application; Construction and characteristics: Diode, BJT, Thyristors, MOSFET, IGBT, TRIAC and GTO; Triggering and commutation circuit for SCR; Driver and snubber circuits; Introduction to wide-band gap devices.

Unit – II: Phase Controlled (AC to DC) Converters

Principle of phase control; One pulse, two pulse, three pulse and six pulse converters; Performance parameters; Dual Converters; Effect of source inductance; Applications.

Unit – III: DC to DC Converters

Introduction; Principle and operation; Control strategies; Types: step down (buck), Step up (boost) and step down/step up (buck/boost) converters and Cuk converter; Steady state operation; Applications.

Unit – IV: DC to AC Converters

Introduction; Types: Single phase half and full bridge VSI, Three phase VSI 120 and 180 degree conduction mode; PWM Techniques; Current source inverter; Introduction to multilevel inverters; Applications.

Unit – V: AC to AC Converters

AC Voltage Controllers: Introduction, On-Off control, Phase Control, Single phase Bidirectional Controllers with R and R-L Loads, Three phase full wave controllers.

Cycloconverters: Single Phase and Three phase Cycloconverter and Matrix Converter.

Text Books:

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1. Ned Mohan, Tore. M. Undeland, William. P. Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley India, Third Edition Reprint, 2009.
2. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Twenty Third Reprint, 2012.

References:

Reference Books:

1. Rashid M. H, “Power Electronics: Circuits, Devices & Applications”, Pearson, Third Edition, 2004.
2. Rama Reddy S. “Fundamentals of Power Electronics”, Narosa Publishing House, Second Edition, 2014.
3. Singh M. D. and Khanchandani K. B., “Power Electronics”, Tata McGraw Hill, 2013.
4. Philip T. Krein, “Elements of Power Electronics”, Oxford University Press, Second Edition, 2015.
5. Joseph Vithayathil, “Power Electronics: Principles and Applications”, Tata McGraw Hill, Second Reprint, 2010.

Journal References:

1. IEEE Transactions on Power Electronics
2. IEEE Journal of Emerging and Selected Topics in Power Electronics
3. IET Power Electronics
4. PE Journal of Power Electronics
5. International Journal of Electrical Power & Energy Systems

Video References:

1. https://www.youtube.com/watch?v=jgh0TNfx0gQ
2. https://youtube.com/playlist?list=PLgwJf8NK-2e5Hnu82T1CYLZ8kbZs4Jx8x&si=ZfCV4 nsbcF4Qmibz

MOOC / NPTEL / SWAYAM Courses:

1. https://nptel.ac.in/courses/108105066
2. https://onlinecourses.nptel.ac.in/noc21_ee01/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE601.1	Explain the operation and characteristics of different types of power semi-conductor devices to choose a suitable switch for a specific application.
R19EE601.2	Build various configurations of phase-controlled converter circuits to analyse their operation, characteristics and performance parameters.
R19EE601.3	Construct and analyse various topologies of DC to DC converters to select the most suitable one for a particular application.
R19EE601.4	Develop dc to ac inverter circuits and apply different PWM techniques to reduce harmonics in the inverter output.
R19EE601.5	Understand the methods of AC to AC power conversion to analyze the performance of these converters with various types of loads.

R19EE602	Non-Conventional Energy Sources	L	T	P	C
		3	0	0	3

1. Course Description:

The course on " Non-Conventional Energy Resources " offers a comprehensive study of renewable energy sources, technologies, integration strategies, and their role in sustainable energy solutions. As the global focus shifts towards reducing greenhouse gas emissions and achieving energy independence, renewable energy systems play a pivotal role in meeting these challenges. This course provides students with a deep understanding of various renewable energy technologies.

2. Course Objectives:

1. To explain the significance and benefits of renewable energy sources in addressing global energy needs and environmental challenges.
2. To describe the operational principles and components involved in wind energy conversion systems, including the methods of harnessing wind power.
3. To outline the key techniques and technologies used in Solar Photovoltaic (PV) and Solar Thermal conversion systems for efficient energy capture and utilization.
4. To illustrate the processes and technologies involved in converting biomass and hydro resources into usable energy, highlighting their applications and benefits.
5. To summarize the fundamental concepts and methods of energy conversion from tidal forces, (OTEC), hydrogen production, fuel cells, and energy storage systems, including their potential impacts on the energy landscape.

3. Syllabus

Unit – I: Renewable Energy Sources

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

Unit – II: Wind Energy

Power in the Wind – Types of Wind Power Plants (WPPs) – Components of WPPs – Working of WPPs – Siting of WPPs – Grid integration issues of WPPs.

Unit – III: Solar PV and Thermal Systems

Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds – Thermal Energy storage system with PCM – Solar Photovoltaic systems: Basic Principle of SPV conversion – Types of PV Systems – Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications.

Unit – IV: Biomass Energy and Hydro Energy

Introduction – Bio mass resources – Energy from Bio mass: conversion processes – Biomass Cogeneration – Environmental Benefits. Geothermal Energy: Basics, Direct Use,

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Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.
Unit – V: Other Renewable Energy Sources
Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell: Principle of working – various types – construction and applications. Energy Storage System – Hybrid Energy Systems.
Text Books:
1. Kothari D. P, Singal K. C, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt. Ltd., Second Edition, 2011. 2. Rai G. D, "Non-Conventional Energy Sources", Khanna Publishers, Fourth Edition, 2009.
References:
Reference Books: 1. Mukerjee A. K. and Nivedita Thakur, "Photovoltaic Systems: Analysis and Design", PHI Learning, 2011. 2. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd., Third Edition, 2015. 3. Godfrey Boyle, "Renewable energy", Oxford University Press in association with the Open University, 2004. 4. Shobh Nath Singh, "Non-conventional Energy resources", Pearson, 2015. **Journal References:** 1. Progress in Photovoltaics 2. Energy and Environment 3. Renewable and Sustainable Energy **Web Resources:** 1. https://www.solarenergy.org/courses/introduction-to-renewable-energy/ 2. https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-019-0232-1 3. https://online.stanford.edu/programs/energy-innovation-and-emerging-technologies-program **MOOC / NPTEL / SWAYAM Courses:** 1. https://onlinecourses.nptel.ac.in/noc24_ph29/preview 2. https://onlinecourses.nptel.ac.in/noc24_ch43/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE602.1	Explain the importance of renewable energy sources
R19EE602.2	Describe the process of wind energy conversion system

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R19EE602.3	Outline the techniques of Solar PV and Solar Thermal conversion system
R19EE602.4	Illustrate the process of energy conversion from Bio-Mass and Hydro Systems
R19EE602.5	Summarize the concepts of energy conversion from tide, OTEC, Hydrogen Production, Fuel Cells and Energy storage systems

R19EE603	**Energy Conservation Practices**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

This intensive course equips professionals with comprehensive strategies for electrical energy conservation. Through in-depth exploration of energy-efficient technologies, power factor improvement, and best practices across various applications – motors, lighting, and electric traction – participants gain the knowledge to optimize energy consumption and reduce operational costs. Additionally, the course delves into electrolytic processes and battery storage, providing insights into emerging energy storage solutions.

2. Course Objectives:

1. To understand the principles of energy conservation and its significance.
2. To develop skills in identifying and implementing energy-saving measures in electrical systems.
3. To acquire knowledge of lighting systems and energy-efficient lighting practices.
4. To understand the fundamentals of electric traction and its energy efficiency.
5. To gain knowledge of energy storage technologies and their applications.

3. Syllabus

Unit – I: Introduction to Energy Conservation

Need for electrical energy conservation - methods – energy efficient equipment – energy management – energy auditing - Features of Energy Conservation Act – Economics of power factor improvement – design for improvement of power factor using power capacitors – DSM techniques.

Unit – II: Energy Conservation in Electrical System

Energy Conservation potential in motors – Pumps – Fans and Compressors – Refrigeration and HVAC system, operation and maintenance practices for electrical energy conservation – Case studies.

Unit – III: Energy Conservation in Lighting System

Laws of illumination – Calculation of illumination – Street lighting and Flood lighting – MSCP – Choice of Lighting – Different types of illumination sources and Energy efficiency – Control of Lighting – Lighting standards for industry and Commercial – Energy conservation measures for lighting.

Unit – IV: Electric Traction

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Characteristics of traction motors – Choice of an Electric Motor – Control of traction motors – Systems of railway electrification – Power and Energy output from driving axles – Specific Energy output and consumption – Braking methods – Current collection systems – Recent trends in electric traction – Introduction to Aircraft electrical system.

Unit – V: Electrolytic Process and Storage of Electricity

Electrolysis – simple problems involving Faraday's laws of electrolysis - Electroplating – Nickel iron batteries – Lead acid Batteries – components and materials - capacity rating of batteries – battery chargers – Method of charging and maintenance – Case studies.

Text Books:

1. Gupta J.B., "Utilization of Electric Power and Electric Traction", S.K. Kataria& Sons, 2-12.

References:

Reference Books:

1. Chakrabarti A., Soni M.L., Gupta P.V. and Bhatnagar U.S., "A Textbook on Power System Engineering", Dhanpat Rai & Co., 2-1-.
2. Taylor E. Openshaw, "Utilization of Electrical Energy", Orient Longman, 2--6.
3. AmlanChakrabarti, "Energy Engineering and Management", PHI, Second Edition, 2-18.
4. Suryanarayana N.V, "Utilisation of Electric power", New Age International Limited, Reprint, 2--5.
5. CB Smith, "Energy Management Principles", Elsevier, Second Edition, 2-16.

Journal References:

1. Energy
2. Applied Energy
3. Energy Efficiency
4. IEEE Transactions on Industrial Electronics (TIE)
5. Electric Traction

Web Resources:

1. https://www.energystar.gov/
2. https://www.energy.gov/eere
3. https://www.ashrae.org/
4. https://www.ies.org/
5. https://uitp.org/

MOOC / NPTEL / SWAYAM Courses:

1. https://onlinecourses.swayam2.ac.in/nou23_es05/preview
2. https://www.coursera.org/learn/energy-and-environment

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE603.1	Summarize the concept of energy conservation and industrial energy management.
R19EE603.2	Identify various energy conservation methods in electrical utilities and best operating practices.
R19EE603.3	Develop the concept of lighting system for all applications along with various energy conservation measures.
R19EE603.4	Select traction motor, discuss their energy performance and basic applications in railways and aircraft electrical system.
R19EE603.5	Explain the process, technology and application of electrolytic process.

R19EE604	Energy Auditing and Management	L	T	P	C
		3	0	0	3

1. Course Description:

This comprehensive course equips professionals with the expertise to conduct energy audits across various sectors. Through in-depth exploration of energy principles, regulations, and auditing methodologies, participants gain the ability to identify and implement energy-saving measures in electrical utilities, HVAC systems, and thermal processes. Financial analysis techniques are also covered, enabling participants to evaluate the economic viability of energy-saving projects.

2. Course Objectives:

1. To analyze energy consumption patterns and evaluate potential energy savings through comprehensive energy audits.
2. To evaluate the effectiveness of energy management strategies for electrical systems
3. To apply engineering principles to optimize the performance of fluid handling systems.
4. To evaluate the energy efficiency of thermal systems and develop strategies for improvement.
5. To create and implement cost-effective energy efficiency projects.

3. Syllabus

Unit – I: Introduction to Energy Auditing

Classification of Energy - Energy Scenario - Energy Needs of Growing Economy - Energy Pricing in India – Energy and Environment - Energy Conservation Act - Role of energy

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managers and auditors-Energy Auditing Types, objectives and Methodology -Audit instruments.

Unit – II: Energy Audit in Electrical Utilities

Electric Power Supply Systems - Electricity Billing – Electrical Load Management and Maximum Demand Control- Power factor improvement and its benefit - Factors involved in determination of motor efficiency- Energy efficient motors- Lightning-Energy efficient light sources-Energy Conservation in Lighting schemes.

Unit – III: Fans, Blowers and Pumps

Fan Types - Blower Types- Fan Performance evaluation- Fan Laws- Flow control strategies- Pumps- Types – Factors affecting pump performance- System characteristics- Efficient Pumping system operation- Flow Control Strategies- Energy conservation opportunities in pumping systems

Unit – IV: Energy Audit in Thermal Utilities

Steam – Introduction, Properties of steam, Steam distribution systems - Boilers- Types and Classification- Performance Evaluation of Boilers – Boiler Efficiency- Direct and Indirect methods – Energy Conservation opportunities in boilers- Principle of cogeneration – Technical options for cogeneration- Waste heat recovery - Classification and benefits.

Unit – V: Project and Financial Management

Financial analysis techniques -Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracting and role of ESCOs.

Text Books:

1. Bureau & Energy Efficiency, "Energy Efficiency in Electrical Utilities", Guide Book for National Certification Examination for Energy Managers and Energy Auditors, 2013. (www.bee - india.nic.in)

References:

Reference Books:

1. Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management & Case Study", Hemisphere, Washington, 1980.
2. Larry C Witte et. al, "Industrial Energy Management & Utilization". Springer Publication, First Edition, 1990.
3. Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical publications,1990.
4. Reay D.A, "Industrial Energy Conservation", Pergamon Press, First Edition, 1977.

Web Resources:

1. https://www.energystar.gov/buildings
2. https://www.ashrae.org/
3. https://www.pumps.org/
4. https://www.chpa.org/
5. https://corporatefinanceinstitute.com/

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MOOC / NPTEL / SWAYAM Courses:
1. https://onlinecourses.swayam2.ac.in/nou23_es05/preview 2. https://www.edx.org/learn/energy/hec-montreal-introduction-to-energy-management-powered-by-retscreen 3. https://sustainabilityeducationacademy.com/courses/online-energy-audit-course/

4. Course Outcomes

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE604.1	Explain the basic of industrial energy audits, objectives, methodology and outcomes.
R19EE604.2	Identify energy consumption pattern of various electrical utilities.
R19EE604.3	Explain possible auditing methods in electric fans, motors and blower along with energy conservation measures.
R19EE604.4	Identify energy consumption pattern of various thermal utility system.
R19EE604.5	Analyse practice calculation methods to prepare viable energy conservation proposals using project and financial management.

<table>
<tr><td rowspan="2">R19EE605</td><td rowspan="2">Introduction to Hybrid and Electric Vehicles</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">1. Course Description:</td></tr>
<tr><td colspan="6">his course provides an in-depth overview of hybrid and electric vehicles (HEVs and EVs), covering their design, operation, and impact on the environment. Students will explore the fundamental principles of vehicle electrification, including battery technology, electric motors, power electronics, and energy management systems. The course also addresses the technological advancements, challenges, and future trends in the field of hybrid and electric vehicles.</td></tr>
<tr><td colspan="6">2. Course Objectives:</td></tr>
<tr><td colspan="6">1. To impart knowledge on the basic principles and components of hybrid and electric vehicles.
2. To facilitate thorough learning on the functions of batteries and their specifications.
3. To explore on the motors used for EVs and the related calculations.
4. To enable students to understand the fundamental components and configuration of a transmission system in electric and conventional vehicles.
5. To equip students with the knowledge on the principles and components of Energy Management Systems and EV charging stations.</td></tr>
<tr><td colspan="6">3. Syllabus</td></tr>
</table>

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Unit – I: Introduction

Introduction to Hybrid Electric Vehicles: History, social and environmental importance, impact of modern drive trains on energy supplies. Motion and dynamic equations for vehicles

Unit – II: Batteries

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries and maintenance.

Unit – III: Electric Drive and Controller

Types of Motors, Selection and sizing of Motor – RPM and Torque calculation of motor – Motor Controllers – Component sizing – Physical locations – Mechanical connection of motor – Electrical connection of motor

Unit – IV: Hybrid and Electric Vehicle Drive Train

Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.

Unit – V: Energy Management System (EMS) and Charging Station

Energy Management System – Software based high level supervisory control – Mode of power. Electric Vehicles charging station – Types – Selection and Sizing of charging station – Components of charging station

Text Books:

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", Second Edition, CRC Press, 2011.

References:

Reference Books:

1. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
3. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003.
4. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug – in Hybrid Electric Vehicles", Springer, 2013.

Video References:

1. https://www.goseeko.com/reference-video/biju-patnaik-university-of-technology-odisha/engineering/electrical-electronics/third-year/sem-2-/electric-and-hybrid-vehicles-1/unit-2-hybrid-electric-drive-trains-1
2. https://www.ti.com/video/6327216475112

Web Resources:

1. https://archive.nptel.ac.in/courses/108/103/108103009/

2. https://www.cranfield.ac.uk/courses/short/transport-systems/hybrid-electric-vehicles-introduction **MOOC / NPTEL / SWAYAM Course:** 1. https://onlinecourses.swayam2.ac.in/nou24_ec10/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE605.1	Explain the basic Concepts of hybrid and Electric vehicles.
R19EE605.2	Illustrate the basic parameters and the characteristics of batteries.
R19EE605.3	Aply the concepts for selection of electric drives and its controllers.
R19EE605.4	Understand the concept of Transmission system in Hybrid and Electric vehicle
R19EE605.5	Explain the basic concepts of Energy management system and charging station.

R19EE606	**Design of Solar Photovoltaic Systems**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description

The course "Design of Solar Photovoltaic Systems" offers a comprehensive exploration into the principles, technologies, and methodologies involved in designing efficient and cost-effective solar photovoltaic (PV) systems. As solar energy continues to play a crucial role in the transition towards renewable energy, there is a growing demand for professionals who can design, implement, and optimize solar PV systems for various applications.

2. Course Objectives:

1. To explain the fundamental principles and operational mechanisms of Solar Photovoltaic (PV) systems.
2. To outline and describe the key components and their functions within Solar PV systems.
3. To apply theoretical concepts to model and design a stand-alone Solar PV system tailored to specific energy needs and conditions.
4. To utilize design principles and technical knowledge to create and optimize a grid-connected Solar PV system for efficient energy integration.
5. To explain and demonstrate the best practices for the installation, operation, and maintenance of Solar PV systems to ensure optimal performance and longevity.

3. Syllabus

Unit – I: Introduction to Solar PV Systems

Introduction to Solar Radiation: Optimum orientation of Solar PV modules – Solar related measuring devices. Solar PV Electricity – Introduction of Solar PV Modules – Interconnections of PV Modules.

Unit – II: Components of Solar PV Systems

Types of Solar PV systems, Photovoltaic System Components: Introduction to batteries – Charge controller – MPPT – Solar PV inverters – Wires and Cable sizing – Junction Boxes – Combiner Boxes – Fuses.

Unit – III: Stand – Alone PV System

Preparation of Load Chart – Solar Array Sizing – Battery Bank Sizing – Charge Controller Selection – Inverter Selection.

Unit – IV: Grid – Connected PV System

Assessment of Site condition – Estimation of Annual energy usage – average solar radiation of the site – Required demand – Inverter Selection – Solar Array Sizing – Balance of System (BOS) Selection – Net metering.

Unit – V: Installation, Troubleshooting and Safety of PV System

Preparation and General Consideration for Installation – Installation of Array support structure, Modules, Combiner boxes, AC and DC DB's, Inverter – Maintenance and troubleshooting Solar PV system – Electrical safety – Mechanical Safety – Safety Precautions for Batteries.

Text Books:

1. Solanki C.S, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning, 2015.
2. Rai. G.D, "Solar energy utilization", Khanna publishes, 1993.
3. Wenham S.R, Green M.A, Watt M.E, Corkish R, "Applied Photovoltaics", Earthscan, Third Edition, 2011.

References:

Reference Books:

1. McNeils, Frenkel, Desai, "Solar & Wind Energy Technologies", Wiley Eastern, 1990
2. Sukhatme S.P, "Solar Energy", Tata McGraw Hill,1987.
3. Eduardo Lorenzo G. Araujo, "Solar Electricity Engineering of Photovoltaic Systems", Progensa,1994

Journal References:

1. Progress in Photovoltaics
2. Energy and Environment
3. Renewable and Sustainable Energy
4. Advanced Energy Materials

Web Resources:

1. https://www.solarenergy.org/courses/introduction-to-renewable-energy/

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2. https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-019-0232-1 3. https://online.stanford.edu/programs/energy-innovation-and-emerging-technologies-program
MOOC / NPTEL / SWAYAM Courses: 1. https://onlinecourses.nptel.ac.in/noc24_ph29/preview 2. https://onlinecourses.nptel.ac.in/noc24_ch43/preview

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE606.1	Explain the fundamentals of Solar PV Systems
R19EE606.2	Outline the Components of Solar PV systems
R19EE606.3	Apply the concepts to model a Stand Alone PV System
R19EE606.4	Utilize the concepts to design a Grid connected PV System
R19EE606.5	Explain the Installation and Maintenance techniques of a Solar PV System

R19EE607	**PLC and SCADA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description:					
The course aims to provide a comprehensive understanding of PLCs in industrial automation, covering their history, architecture, and capabilities. Students will learn PLC programming, including ladder logic and GX Works 2 software. The course includes HMI programming, interfacing PLCs with HMIs, and real-time problem-solving. Additionally, it covers Variable Frequency Drives (VFDs) and their configuration. Finally, the course introduces SCADA systems, focusing on architecture and communication protocols.					
2. Course Objectives:					
1. To provide the knowledge about the selection of PLC for different applications. 2. To enable the students to develop the ladder logic program for different industrial applications. 3. To provide the knowledge on configuration of GOT and its various functions in industrial automation. 4. To acquire the knowledge about programming of variable frequency drives for induction motor speed control applications. 5. To design and develop the SCADA system for totally integrated automation.					
3. Syllabus					
Unit – I: Introduction To PLC					

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History and developments in industrial automation; Control elements in industrial automation; Introduction: Basics of PLC, Advantages, Capabilities of PLC, Architecture of PLC, Scan cycle and Types of PLC; Types of sensors and I/O devices; Types of I/O modules; Configuring a PLC.

Unit – II: Programming of PLC

Types of Programming: Ladder Programming; Creating programs using GX Works 2: Configuration of modular PLC and different modules in GX Works 2 platform; Process Control Programs using Relay Ladder Logic; PLC arithmetic functions; Timers and counters; Data transfer, Comparison and Manipulation instructions.

Unit – III: HMI Programming and Interfacing

Necessity and Role in Industrial Automation; New project creation using GT Designer: Text display, various screen and object creation; Interfacing PLC to HMI; Developing solutions for real time problems.

Unit – IV: Variable Frequency Drives

Introduction to VFD: Basic v/f concept, Power wiring and Control wiring. Configuration of VFD: Parameter setting; JOG operation; Buffer Memory; Speed Control of Induction Motor.

Unit – V: SCADA

Overview: Developer and runtime packages, Architecture, Tools and Tag; Internal & External graphics; Communication Protocols of SCADA.

Text Books:

1. Bolton W, "Programmable Logic Controllers", Elsevier, 2015.

References:

Reference Books:

1. Frank D Petruzella, "Programmable logic controllers", McGraw Hill, 2016.
2. John R Hackworth and Fredrick D Hackworth Jr., "Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, 2006.
3. Mitsubishi Electric India PLC, SCADA, SERVO, VFD & ROBOTICS Programming Manuals.

Journal References:

1. IEEE Transactions on Industrial Electronics
2. Journal of Manufacturing Systems
3. International Journal of Automation and Control (IJAAC)
4. Control Engineering Practice
5. Journal of Process Control

Web Resources:

1. https://www.plcacademy.com/
2. https://www.automationdirect.com/programmable-logic-controllers/plc-training
3. https://www.mitsubishielectric.com/fa/products/cnt/plc/
4. https://www.youtube.com/@realpars

5. https://www.youtube.com/watch?v=gexOS7imMsE

MOOC / NPTEL / SWAYAM Courses:

1. https://onlinecourses.nptel.ac.in/noc20_me39/preview
2. https://www.eit.edu.au/courses/professional-certificate-of-competency-programmable-logic-controllers-plcs-scada-systems/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19EE607.1	Realize the architecture of PLC and different types of I/O devices
R19EE607.2	Design the HMI screens and I/O functions for the project development
R19EE607.3	Configure the Variable Frequency Drives for the speed control of Induction Motor
R19EE607.4	Develop the program for different Pick and Place Applications using Industrial Robot
R19EE607.5	Control the PLC, HMI from remote station using SCADA

R19IT601	**Introduction to Software Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course is designed to equip students with essential skills in software engineering, focusing on applying the right development models for various scenarios. Students will learn to effectively gather, analyze, and document project requirements through requirement engineering techniques. The course emphasizes evaluating and selecting suitable design models tailored to specific application needs. Additionally, students will apply testing principles to ensure the quality of software projects and utilize estimation techniques to manage resources, timelines, and costs for successful project management.

2. Course Objectives:

1. To select and apply appropriate software development models for specific scenarios
2. To gain skills in gathering, analysing, and documenting project requirements effectively.
3. To develop the ability to compare and choose suitable design models for various applications.
4. To apply software testing techniques to ensure project quality during development.
5. To apply estimation techniques to manage resources and project timelines effectively.

3. Syllabus:

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Unit-I: Software Product and Process

Introduction to Software Engineering, Software Process, Perspective and Specialized Process Models – System Engineering – Computer Based System – Business Process Engineering Overview – Product Engineering Overview.

Unit-II: Requirements Analysis

Software Requirements: Functional and Non-Functional, User requirements, System requirements – Software Requirements Document - IEEE Standards for SRS – Requirement Engineering Process: Feasibility Studies, Requirements elicitation – Requirements analysis modeling techniques – requirements validation.

Unit-III: Software Design

Design process: Design Concepts, Quality-Design Model, Heuristics - Architectural Design: Architectural styles-Architectural Mapping using Data Flow - Performing User interface design: Interface analysis and design models-Component level Design.

Unit-IV: Testing and Maintenance

Software testing fundamentals – Testing Strategies: White box testing – control structure testing, black box testing – Unit Testing, Integration Testing, Acceptance Testing – Regression Testing, Validation Testing, System Testing and Debugging – Software Implementation Techniques: Coding practices – Refactoring – Reverse and Forward Engineering.

Unit-V: Project Management

Software Project Management: Estimation – LOC, FP Based Estimation, Make/Buy Decision COCOMO Model – Project Scheduling – Scheduling, Earned Value Analysis Planning – Project Plan, Planning Process, RFP Risk Management – Identification, Projection - Risk Management-Risk Identification-RMMMPlan-CASE TOOLS

Text Books:

1. R.S. Pressman, "Software Engineering – A Practitioner's Approach", Eighth Edition, McGraw HillInternational Edition, 2015.
2. Ian Sommerville — "Software Engineering", 10th Edition, Pearson Education, 2016.

References:

1. Ronald J. Leach, "Introduction to Software Engineering", CRC Press, 2016.
2. Rod Stephens "Beginning Software Engineering", John Wiley & Sons, 2015.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT601.1	Apply appropriate software engineering model for a givendevelopment scenario.

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R19IT601.2	Apply appropriate requirement engineering techniques for realtime projects.
R19IT601.3	Compare and choose the suitable design models for the givenapplication scenario.
R19IT601.4	Apply the testing principles to software project development.
R19IT601.5	Apply the estimation techniques for software projectmanagement.

R19IT602	**Web Programming**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course focuses on equipping students with practical skills in modern web development. Students will understand and apply object-oriented programming concepts using Java, along with mastering client-side programming for creating dynamic user interfaces. The course also covers server-side programming techniques, enabling students to build robust backend systems. Additionally, learners will explore PHP frameworks and the MVC architecture to structure projects efficiently. Finally, students will utilize relevant web frameworks and web services to build, deploy, and manage scalable and interactive web applications.

2. Course Objectives:

1. To implement object-oriented programming principles and Java semantics in real-world applications.
2. To Master the use of client-side technologies such as HTML, CSS, and JavaScript for interactive web development.
3. To develop skills to implement server-side functionality using technologies like Java, Node.js, or PHP for dynamic web applications.
4. To build web applications using PHP frameworks and apply the MVC architecture for organized project development.
5. To apply web frameworks and integrate web services to build, deploy, and manage scalable web applications.

3. Syllabus:

Unit-I: Web Fundamentals

Web Essentials: Clients, Servers and Communication – The Internet – Basic Internet protocols – World wide web – HTTP Request Message – HTTP Response Message – Web Clients – Web Servers – HTML5 – Tables – Lists – Image – HTML5 control elements – Semantic elements – Drag and Drop – Audio –Video controls - CSS3 – Inline, embedded and external style sheets – Rule cascading – Inheritance – Backgrounds – Border Images – Colors – Shadows – Text – Transformations – Transitions – Animations

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Unit-II: Client Side Scripting Language
Java Script: An introduction to JavaScript–JavaScript DOM Model-Date and Objects,-Regular Expressions- Exception Handling-Validation-Built-in objects-Event Handling DHTML with JavaScript
Unit-III: Server Side Programming
Servlets: Java Servlet Architecture- Servlet Life Cycle- Form GET and POST actions Session Handling- Understanding Cookies- Installing and Configuring Apache Tomcat Web Server-Database Connectivity: JDBC perspectives, JDBC program example - JSP: Understanding Java Server Pages- JSP Standard Tag Library (JSTL)-Creating HTML forms by embedding JSP code.
Unit-IV: PHP and XML
Functions: Built-in Functions, User defined functions – Function Prototypes –Recursion – Command Line Argument -Arrays and Functions – Strings and Functions. Pointers: Declaration – Pointer operators – Pointer arithmetic -Passing Pointers to a Function – Pointers and one-dimensional arrays – Dynamic Memory Allocation
Unit-V: Introduction to Ajax and Web Services
AJAX: Ajax Client Server Architecture-XML Http Request Object-Call Back Methods: Web Services: Introduction- Java web services Basics – Creating, Publishing, Testing and Describing a Web services (WSDL)-Consuming a web service, Database Driven web service from an application –SOAP.
Text Books:
1. Deitel and Deitel and Nieto, ―Internet and World Wide Web - How to Program, Prentice Hall, 5th Edition, 2011.
References:
1. Stephen Wynkoop and John Burke ―Running a Perfect Website‖, QUE, 2nd Edition,1999. 2. Chris Bates, Web Programming – Building Intranet Applications, 3rd Edition, Wiley Publications, 2009 3. Jeffrey C and Jackson, ―Web Technologies A Computer Science Perspective‖, Pearson Education, 2011. 4. Gopalan N.P. and Akilandeswari J., ―Web Technology‖, Prentice Hall of India, 2011. 5. UttamK.Roy, ―Web Technologies‖, Oxford University Press, 2011.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT602.1	Understand and apply the features of object-oriented programming paradigm and Java Semantics
R19IT602.2	Understand and apply the concepts of Client-side programming

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R19IT602.3	Understand and apply the concepts of Server-Side Programming
R19IT602.4	Understand and apply the features of PHP frameworks and project development using MVC Architecture
R19IT602.5	Use relevant Web Frameworks along with web services for application building and deployment

R19IT603	**Basic of Software Testing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course focuses on equipping students with the knowledge and skills to design and execute effective software testing strategies across various domains. Students will learn to define appropriate test cases and understand fundamental concepts in software testing, including strategies and methods tailored to specific development scenarios. The course covers selecting suitable tests for different applications, designing detailed test cases, and preparing comprehensive test plans. Additionally, students will gain hands-on experience with automated testing tools to enhance efficiency and accuracy in the software testing process.

2. Course Objectives:

1. To identify and define suitable test cases for various software development domains.
2. To gain knowledge of fundamental testing concepts, strategies, and methods for different software domains.
3. To develop the ability to select the most appropriate tests to ensure software quality in different scenarios.
4. To learn to design effective test cases and prepare comprehensive test plan documents for software projects.
5. To understand and apply automated testing tools to streamline the software testing process.

3. Syllabus:

Unit-I: Fundamentals of Testing

Testing as an Engineering Activity – Testing as a Process – Basic definitions – Software Testing Principles – The Tester's Role in a Software Development Organization – Origins of Defects – Cost of defects – Defect Classes – The Defect Repository and Test Design – Defect Examples – Developer/Tester Support of Developing a Defect Repository.

Unit-II: Test Case Design Strategies

Test case Design Strategies – Using Black Box Approach to Test Case Design – Random Testing – Requirements based testing – Boundary Value Analysis – Equivalence Class Partitioning – State-based testing – Cause-effect graphing – Compatibility testing – user documentation testing – domain testing – Using White Box Approach to Test design

static testing vs. structural testing – code functional testing – Coverage and Control Flow Graphs – Covering Code Logic – Paths – code complexity testing – Evaluating Test Adequacy Criteria
Unit-III: Levels of Testing
The need for Levers of Testing – Unit Test – Unit Test Planning – Designing the Unit Tests – The Test Harness – Running the Unit tests and Recording results – Integration tests – Designing Integration Tests –System Testing – Acceptance testing – Performance testing – Regression Testing – Internationalization testing – Ad-hoc testing – Alpha, Beta Tests – Usability and Accessibility testing – Configuration testing – Compatibility testing – Website testing.
Unit-IV: Test Management
People and organizational issues in testing – Organization structures for testing teams – testing services – Test Planning – Test Plan Components – Test Plan Attachments – Locating Test Items – test management – test process – Reporting Test Results – The role of three groups in Test Planning and Policy Development – Introducing the test specialist – Skills needed by a test specialist – Building a Testing Group.
Unit-V: Test Automation
Software test automation – skill needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation – Test metrics and measurements – project, progress and productivity metrics.
Text Books:
1. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Fourth Edition, CRC Press, 2013. 2. Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2006. 3. Ilene Burnstein, "Practical Software Testing", Springer International Edition, 2003.
References:
1. Ali Mili, Fairouz Chier, "Software Testing: Concepts and Operations", Wiley, 2015. 2. Dorothy Graham, Mark Fewster, "Experiences of Test Automation: Case Studies of Software TestAutomation", Pearson Education, 2012. 3. Aditya P. Mathur, "Foundations of Software Testing _ Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT603.1	Define the test cases which are suitable for a software development for different domain
R19IT603.2	Explain fundamental concepts in software testing, strategies and methods for a software development for different domains.

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R19IT603.3	Determine the suitable tests to be carried out.
R19IT603.4	Design test cases and prepare a test plan document.
R19IT603.5	Describe the usage of the automatic testing tools.

R19IT604	Introduction to Blockchain Technology	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive understanding of blockchain technology, equipping students with the ability to describe its foundational concepts and emerging models. Students will explore the process of cryptocurrency issuance, proof-of-work, and alternative consensus mechanisms, while also gaining familiarity with the operational aspects of the cryptocurrency ecosystem. The course emphasizes practical implementation, enabling students to integrate blockchain technology in various domains, applying it to real-world scenarios and multiple perspectives.

2. Course Objectives:

1. To describe the foundational concepts and explain the workings of blockchain technology.
2. To explore and comprehend emerging abstract models in blockchain technology.
3. To gain insight into cryptocurrency issuance, proof-of-work, and alternative consensus mechanisms.
4. To understand the functional and operational aspects of the cryptocurrency ecosystem.
5. To apply and implement blockchain technology across various domains and perspectives.

3. Syllabus:

Unit-I: Basics of Blockchain

Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit-II: Blockchain

Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

Unit-III: Distributed Consensus

Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

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Unit-IV: Cryptocurrency
History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin
Unit-V: Cryptocurrency Regulation
Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. **Applications:** Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain.
Text Books:
1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin andCryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016). 2. Imran Bashir, "Mastering Blockchain - Distributed ledgers, decentralization and smart contracts explained", Packt Publishing Ltd., Second Edition, 2017.
References:
1. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, O'Reilly Media, Inc., December 2014 2. Bikramaditya Singhal, Gautama, Panda, "Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions", Apress. 3. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger", Yellow paper 2014.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT604.1	Describe and explain blockchain technology
R19IT604.2	Understand emerging abstract models for Blockchain Technology.
R19IT604.3	Understand the process of Cryptocurrencies issuance, proof-of-work and alternative consensus mechanisms and transaction
R19IT604.4	Familiarize the functional /operational aspects of Cryptocurrency ecosystem
R19IT604.5	Integrate ideas from various domains and implement them using block chain technology in different perspectives.

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R19IT605	Soft Computing Technologies	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a deep dive into the fundamentals of artificial intelligence, beginning with an understanding of human intelligence and its connection to AI. Students will explore the basics of fuzzy logic and neural networks, delving into concepts like fuzzy sets and heuristic approaches inspired by human reasoning. The course also examines genetic algorithms and random search procedures, emphasizing their role in self-learning and optimization tasks. In addition, students will gain exposure to current research problems and methods in soft computing, fostering an understanding of cutting-edge developments in this field.

2. Course Objectives:

1. To learn the fundamental concepts of human intelligence and how they relate to artificial intelligence.
2. To gain a foundational understanding of fuzzy logic and neural networks.
3. To explore the concepts of fuzzy sets, fuzzy logic, and the use of heuristics derived from human experience.
4. To investigate the use of genetic algorithms and random search methods for finding global optima in self-learning scenarios.
5. To develop familiarity with current research challenges and methods in soft computing techniques.

3. Syllabus:

Unit-I: Introduction to Soft Computing

Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms, Associative Memory, Adaptive Resonance Theory, Classification, Clustering, Bayesian Networks

Unit-II: Artificial Neural Networks

Neural Network: Biological and Artificial Neuron, Neural Networks, Supervised and UnsupervisedLearning. Single Layer Perceptron - Multilayer Perceptron – Back propagation Learning.

Unit-III: Fuzzy Systems

Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets – Classical Relations and Fuzzy Relations - Membership Functions -Defuzzification – Fuzzy Arithmetic and Fuzzy Measures -Fuzzy Rule Base and Approximate Reasoning

Unit-IV: Genetic Algorithms

Basic Concepts- Working Principles -Encoding- Fitness Function – Reproduction - Inheritance Operators – Cross Over – Inversion and Deletion -Mutation Operator

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Unit-V: Hybrid Systems
Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic -GA Based Weight Determination – LR- Type Fuzzy Numbers – Fuzzy Neuron – Fuzzy BP Architecture – Learning in Fuzzy BP
Text Books:
1. Herbert Schildt, "C – The Complete Reference", Tata McGraw Hill Publishing Company, New Delhi, 2017. 2. N.P.Padhy, S.P.Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015 3. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004
References:
1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, —Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2002. 2. KwangH.Lee, —First course on Fuzzy Theory and Applications, Springer, 2005. 3. George J. Klir and Bo Yuan, —Fuzzy Sets and Fuzzy Logic-Theory and Applications, Prentice Hall,1996. 4. S.N.Sivanandam , S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2nd Edition, 2011.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT605.1	Understand human intelligence and AI
R19IT605.2	Generalize basics of Fuzzy logic and neural networks
R19IT605.3	Discuss the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience
R19IT605.4	Examine with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations
R19IT605.5	Experiment some familiarity with current research problems and research methods in Soft Computing Techniques.

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R19IT606	Fundamentals of IT Infrastructure Management	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides a comprehensive understanding of IT infrastructure design, starting with the basics of ITIL and its role in improving IT services. Students will explore various IT infrastructure management operations and learn to distinguish their key components. The course also covers strategic methods for managing storage in IT environments and introduces the essentials of security management in Information Technology. Additionally, students will stay up to date with the latest global trends in IT, gaining insight into current innovations and how they impact the industry worldwide.

2. Course Objectives:

1. To learn the fundamental principles of IT infrastructure design and the ITIL framework.
2. To develop the ability to differentiate between different IT infrastructure management operations.
3. To gain knowledge of strategic methods for managing storage in IT systems.
4. To learn the principles and practices of security management in Information Technology.
5. To gain detailed knowledge of recent trends and innovations in IT on a global scale.

3. Syllabus:

Unit-I: IT Infrastructure: Overview

Introduction - Challenges in IT Infrastructure Management, Design Issues- Determining Customer's Requirements, IT Systems and Service Management Process, IT Infrastructure Library.

Unit-II: IT Infrastructure Management

Service Delivery Process: Service Level Agreements, Financial Management, IT Service Continuity Management, Capacity Management, Availability Management.

Unit-III: Storage Management

Introduction, Backup and Storage, Archive and Retrieve, Disaster Recovery, Space Management, Database and Application Protection, BMR, and Data Retention.

Unit-IV: Security Management

Security Management: Introduction, Computer Security, Internet Security, Physical Security, Identity Management, Access Control, Intrusion Detection.

Unit-V: Emerging Trends in IT

E-Commerce, Electronic Data Interchange, Global System for Mobile Communication (GSM), Bluetooth, Infrared Technology.

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Text Books:
1. Phalguni Gupta, "IT Infrastructure and Its Management", Tata McGraw Hill Publishing Company, New Delhi, 2010. 2. Rich Schiesser, "IT Systems Management: Designing, Implementing, and Managing World-Class Infrastructures", Pearson, 2001.
References:
1. S.C.Mourya," IT Infrastructure and Its Management- A conceptual Approach", TechnicalPublications, 2014. 2. Anita Sengar "IT Infrastructure Management", S K Kataria publications, 2012. 3. Mani Subrahmanian, "Network Management, Principles and Practice", Pearson Education,2010.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT606.1	Understand the basics of IT infrastructure design and ITIL.
R19IT606.2	Distinguish between various IT Infrastructure Management Operations.
R19IT606.3	Understand the strategic methods of storage management in Information Technology.
R19IT606.4	Able to know the Security Management in Information Technology.
R19IT606.5	Able to Know about the Detailed Knowledge of IT Recent Trends in Globally.

R19IT607	**Mobile Application Development**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:
This course focuses on the intricacies of mobile application design and development, starting with an exploration of the challenges developers face in creating user-friendly and efficient applications. Students will learn to apply practical knowledge to design mobile applications that meet specific requirements, and they will implement these designs using the Android SDK. The course covers the development of applications utilizing various components of the Android framework, equipping students with the skills to build robust mobile solutions. Additionally, learners will gain hands-on experience in integrating file handling and database management into their Android applications, ensuring they can create fully functional and data-driven mobile experiences.
2. Course Objectives:

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1. To understand and articulate the common challenges faced in the design and development of mobile applications. 2. To utilize practical knowledge to create designs for mobile applications tailored to specific user needs. 3. To learn to implement mobile application designs using the Android Software Development Kit (SDK). 4. To gain experience in developing mobile applications utilizing various components of the Android framework. 5. To develop Android applications that effectively integrate file handling and database management functionalities.
3. Syllabus:
Unit-I: Fundamentals of Android
Introduction to Android, Android versions and its feature,Android Development Environment - SystemRequirements, Android SDK, Installing Java, and ADT bundle - Eclipse Integrated Development Environment (IDE), Creating Android Virtual Devices (AVDs)- Market and business drivers for mobile applications – Requirements gathering and validation for mobile applications.
Unit-II: Design Aspects
Introduction – Basics of embedded systems design – Embedded OS - Design constraints for mobile applications, both hardware and software related – Architecting mobile applications – Android Libraries, Application Framework, Creating a New Android Project , Defining the Project Name and SDK Settings, Project Configuration Settings, Configuring the Launcher Icon, Creating an Activity, Running the Application in the AVD, Stopping a Running Application, Modifying the Example Application, Reviewing the Layout and Resource Files
Unit-III: Android Development Platform
Understanding Java SE and Virtual Machine, The Directory Structure of an Android Project, CommonDefault Resources Folders, The Values Folder, Leveraging Android XML, Screen Sizes , Launching Your Application: The AndroidManifest.xml File,Creating Your First Android Application
Unit-IV: Android Framework Overview
Android Application Components, Android Activities: Defining the UI, Android Services: Processing in the Background, Broadcast Receivers: Announcements and Notifications Content Providers: Data Management, Android Intent Objects: Messaging for Components, Android Manifest XML: Declaring Your Components, Views and View Groups, Android Layout Managers, The View Hierarchy, Designing an Android User Interface using the Graphical Layout Tool
Unit-V: Files, Content Providers, and Databases
Saving and Loading Files, SQLite Databases, Android Database Design, Exposing Access

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to a Data Source through a Content Provider, Content Provider Registration, Native Content Providers, Packaging and deployment – Interaction with server side applications – Using Google Maps, GPS and Wifi – Integration with social media applications
Text Books:
1. Code Complete: A Practical Handbook of Software Construction, 2016, 2nd Edition by Steve McConnell. 2. Mobile Apps Made Simple: The Ultimate Guide to Quickly Creating, Designing and Utilizing MobileApps for Your Business, 2016,2nd Edition by Jonathan McCallister 3. Android Application Development Cookbook- 2016, Second Edition by Rick Boyer and Kyle Mew
References:
1. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox, 2012 2. Charlie Collins, Michael Galpin and Matthias Kappler, “Android in Practice”, DreamTech, 2012 3. James Dovey and Ash Furrow, “Beginning Objective C”, Apress, 2012. 4. David Mark, Jack Nutting, Jeff LaMarche and Frederic Olsson, “Beginning iOS 6 Development: Exploring the iOS SDK”, Apress, 2013.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT607.1	Describe the challenges in mobile application design and development
R19IT607.2	Use Practical Knowledge of the design for mobile applications forspecific requirements
R19IT607.3	Implement the design using Android SDK
R19IT607.4	Develop applications using components of android framework
R19IT607.5	Develop android applications including files and databases

<table>
<tr><td rowspan="2">R19IT651</td><td rowspan="2">Basics of Cloud Technology</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td colspan="6">1. Course Description:</td></tr>
<tr><td colspan="6">Delve into Cloud Computing fundamentals, virtualization, and deployment models, alongside software security objectives, design principles, and development practices. Assess risks, challenges, and threats to infrastructure, data, and access control, while addressing security architecture issues, identity management, and autonomic security for comprehensive cloud protection and management</td></tr>
<tr><td colspan="6">2. Course Objectives:</td></tr>
</table>

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To make students familiar with: 1. Fundamentals of Cloud Computing 2. The Concepts of Virtualization and the Cloud delivery and Deployment Models 3. Cloud computing software security objectives, design principles and development practices 4. Cloud computing risks, challenges and threats to infrastructure, data and access control 5. Cloud computing security architectural issues, Identity management and Autonomic security
3. Syllabus:
Unit-I: Cloud Computing fundamentals
Essential characteristics, Architectural Influences, Technological Influences, and Operational Influences.
Unit-II: Cloud Computing Architecture
Cloud Delivery models, The SPI Framework, Cloud Software as a Service (SaaS) , Cloud Platform as a Service(PaaS), Cloud Infrastructure as a Service(IaaS), Cloud deployment models, Public Clouds, Community Clouds, Hybrid Clouds, Alternative Deployment models, Expected benefits.
Unit-III: Cloud Computing Software Security fundamentals
Cloud Information Security Objectives, Confidentiality, Integrity, Availability, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Secure Development practices, Approaches to Cloud Software Requirement Engineering, Cloud Security Policy Implementation.
Unit-IV: Cloud Computing Risk Issues & challenges
Cloud Computing Risk Issues: The CIA Traid, Privacy and Compliance Risks, Threats to Infrastructure, Data and Access Control, Cloud Access Control Issues, Cloud Service Provider Risks.
Unit-V: Cloud Computing Security Architecture
Architectural Considerations, General Issues, Trusted Cloud Computing, Secure Execution environments and Communications, Micro architectures, Identity Management and Access Control, Autonomic Security
List of Experiments:
1. Install Virtual box and create a windows/linux virtual image and analyze the virtual configuration

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2. Register with Amazon AWS and create a windows/linux instance and connect with RDP and create S3 buckets. 3. A case study on Amazon Elastic Cloud Services 4. A case study on Azure 5. Installation and Configuration of Just cloud.
Text Books:
1. Ronald L. Krutz, Russell Dean Vines, "Cloud Security A Comprehensive Guide to secure Cloud Computing" Wiley.
References:
1. John W. itinghouse james F. Ransome, "Cloud Computing Implementation, Management and Security", CRC Press 2. Borko Furht. Armando Escalante, "Handbook of Cloud Computing", Springer 3. Charles Badcock, "Cloud Revolution" , TMH

4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT651.1	Articulate the main concepts, key technologies, strengths, limitations of cloud computing and the possible applications for state-of-the-art cloud computing.
R19IT651.2	Identify the architecture and infrastructure of cloud computing, including cloud delivery and deployment models.
R19IT651.3	Analyze the core issues of cloud computing such as security, privacy, and interoperability
R19IT651.4	Identify problems and analyze the various cloud computing solutions.
R19IT651.5	Analyze appropriate cloud computing solutions and recommendations according to the applications used.

R19IT652	**Introduction to Computer Networks**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**
1. Course Description:					
This course provides a comprehensive understanding of computer networks, beginning with the division of network functionalities into layers and the role of transmission media. Students will study data link layer protocols and be introduced to IEEE standards that define how networks operate. The course also covers the tracing of data flow between nodes in a network, providing insights into how information is transmitted efficiently. Learners will gain a solid understanding of different routing protocols used to manage data traffic across networks.					

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Additionally, students will familiarize themselves with various network applications and their functionalities, preparing them for practical applications in the field of networking.

2. Course Objectives:

1. To learn the concept of dividing network functionalities into layers and understand the role of transmission media.
2. To study various data link layer protocols and get introduced to IEEE networking standards.
3. To understand how data flows from one node to another in a network.
4. To gain knowledge of various routing protocols used for directing data in networks.
5. To explore common network applications and understand their functionalities in network environments.

3. Syllabus:

Unit – I: Networking Fundamentals

Computer Networks Applications-Network Types: PAN, LAN, MAN and WAN Network-Internet-Reference Models: OSI Reference Model-TCP/IP Reference Model-Comparison of OSI and TCP/IP-Critique of Reference Models.

Unit-II: Datalink Layer

Framing; Error control including Bit-parity, CRC and Hamming Codes; Reliable transmission and Automatic Repeat Request (ARQ) protocols including Stop-and-Wait, Go-back-N, Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP.

Unit – III: Transport Layer

Elements of Transport Layer Protocols, The Internet Transport Protocols: Details of TCP header and operation, Performance problems in Computer Networks, UDP Header.

Unit – IV: Network Layer

Network Design issues, Routing protocols including distance-vector and link-state approaches Routing Algorithms including Dijkstra's algorithm and distributed Bellman-Ford algorithm; Example protocols: OSPF, RIP, BGP. Approaches to Congestion Control, Packet scheduling, Ipv4 and Ipv6 addressing and headers. Gateway protocol concepts.

Unit – V: Application Layer

DNS–The Domain Name System, Electronic mail, The World wide web: Architectural overview, FTP, HTTP and Mobile web.

List of Experiments:

1. Setting up LAN connections using Ethernet cables, configure IP addresses and subnet masks manually and using DHCP.
2. Installing and configuring a simple HTTP server (e.g., Apache, Nginx), Creating and hosting a basic website, and accessing the website from different computers within the network.
3. Setting up an FTP server, Uploading and downloading files using FTP clients & explore FTP commands and permissions.
4. Configuring a DNS server (e.g., BIND) for domain name resolution, Creating and managing DNS records (A, CNAME, MX records), Testing name resolution using nslookup and dig commands.
5. Configuring a firewall (e.g., iptables) to allow/block specific traffic, implementing access control lists (ACLs) to restrict network access, Testing firewall rules and monitoring network traffic.

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6. Setting up a wireless access point (WAP) and configuring SSIDs and security settings, connecting devices to the wireless network and test connectivity & Analyze wireless network performance and signal strength. 7. Using network monitoring tools (e.g., Wireshark) to capture and analyze network packets, identify network protocols, traffic patterns, and anomalies, troubleshoot network issues based on packet analysis. 8. Designing and simulate network topology with routers, switches, PCs using network simulation software (e.g., Cisco Packet Tracer, GNS3) & Configuring routers with RIP to connect different network. 9. Simulate OSPF protocol in Packet Tracer / GNS3 to optimize network selection among routers. 10. Test network behavior after configuring exterior protocol EIGRP.
Text Books:
1. JamesF. Kurose, KeithW. Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, Pearson Education, 2017. 2. S.Tanenbaum,David J,Wetherall, "Computer Networks Andrew S". Pearson Education India 5th Edition, 2013
References:
1 LarryL.Peterson,BruceS.Davie,"ComputerNetworks:ASystemsApproach",FifthEdition, Morgan Kaufmann Publishers, 2011. 2 BehrouzA.Forouzan,"DatacommunicationandNetworking",FourthEdition,TataMcGraw –Hill, 2011

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT652.1	Understanding of networking concepts, including protocols, topologies, addressing schemes, and OSI/TCP/IP models.
R19IT652.2	Articulate the functions and operations of data link layer protocols such as HDLC, PPP, Ethernet, and IEEE 802.11.
R19IT652.3	Describe and differentiate between various transport layer protocols such as TCP (Transmission Control Protocol) and UDP (User Datagram Protocol)
R19IT652.4	Comprehend the role and functions of the network layer in the OSI and TCP/IP models, including routing, addressing, and packet forwarding.
R19IT652.5	Describe and differentiate between various application layer protocols such as HTTP, FTP, SMTP, DNS, and their functionalities.

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R19IT653	Game Programming Fundamentals	L	T	P	C
		2	0	2	3

1. Course Description:

This course helps the students to gain foundational knowledge in the video game development process. In this course, The students can able to learn about the Game Design, Game play Development, Understand the inner workings of an engaging game such as game play mechanics, artificial intelligence, and user experience, Game Assets.

2. Course Objectives:

1. To learn Game Essentials, Types of Games, Stages of Design process
2. To understand requirements of designing a game
3. To learn how a concept turns into a game, and game world
4. To create a expressive play, characters in the game
5. To learn general principles of level design and design issues of online gaming

3. Syllabus:

Unit – I:Design and Development of Games

Games and Video Games: Game, Conventional Games Versus Video Games, Games for Entertainment, Serious Games; **Designing and Developing Games:** An Approach to the Task, Key Components of Video Games, The Structure of a Video Game, Stages of the Design Process, Game Design Team Roles, Game Design Documents, The Anatomy of a Game Designer.

Unit-II: Understanding the Game Genres

The Major Genres: Genre, The Classic Game Genres; **Understanding Your Player**: VandenBerghe's Five Domains of Play, Demographic Categories, Gamer Dedication, The Dangers of Binary Thinking**; Understanding Your Machine:** Home Game Consoles, Personal Computers, Portable Devices Other Devices.

Unit – III: GAME World

Game Concepts: Getting an Idea, From Idea to Game; **Concept Game Worlds**: Game World, The Purposes of a Game World, The Dimensions of a Game World, Realism

Unit – IV: Characteristics of GAME & Story Telling

Creative and Expressive Play: Self-Defining Play, Creative Play, Other Forms of Expression, Game Modifications; **Character Development:** The Goals of Character Design, The Relationship Between Player and Avatar, Visual Appearances, Character Depth, Audio Design; **Storytelling:** Put Stories in Games, Key Concepts, The Storytelling Engine, Linear Stories, Nonlinear Stories, Granularity, Mechanisms for Advancing the Plot, Emotional Limits of Interactive Stories, Scripted Conversations and Dialogue Trees, When to Write the Story, Other Considerations

Unit – V:Creating the User Experience

General Principles of Level Design: Level Design, Key Design Principles, Layouts, Expanding on the Principles of Level Design, The Level Design Process, Pitfalls of Level Design; **Design Issues for Online Gaming**: Online Games, Advantages of Online Games, Disadvantages of Online Games, Design Issues, Technical Security, Persistent Worlds, Social Problems

Text Books:

1. Ernest Adams," Fundamentals of Game Design", Third Edition, by, New Riders, 2022,ISBN: 9780133435726

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References:
1. Tynan Sylvester, "Designing Games: A Guide to Engineering Experiences", OREILLY Publication, 2013. 2. Briar Lee Mitchell, "Game Design Essentials", Sybex Publications, 2013.
List of Experiments: 1. OpenGL. OpenGL graphics library: basic concepts and usage 2. Data types and multi-platform issues. 3. 3D graphics. 3D objects and conventions. Coordinate systems and transformations. Coding / drawing. Drawing and managing 3D objects. 4. Input and sounds. Handling buttons and other input devices. The XBox 360 controller. Multi-channel sound. Managing game sounds 5. Simple game physics. Moving objects. Concepts in collision detection 6. Cameras and images. Cameras: Othographic, bitmap and perspective views. Loading, drawing and managing images. 7. Texture mapping. Basic concepts of texture application. UV coordinates, texels and rendering operations 8. Mini Project

5. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19IT653.1	Examine the Game Essentials, Types of Games, Stages of Design process
R19IT653.2	Identify the requirements of designing a game
R19IT653.3	Create a expressive play and characters in the game
R19IT653.4	Experiment with the various components of storytelling
R19IT653.5	Apply the general principles of level design and design issues of online gaming

R19ME601	Product Design and Innovation	L	T	P	C
		3	0	0	3

1.Course Description:

This course explores the principles, methodologies, and practices involved in the creation and innovation of products. Students will learn about the complete product design process, from initial research and concept development to prototyping and final production. The course integrates design thinking, user-centered design, and lean methodologies to foster a deep understanding of how to create innovative and marketable products. Through a combination of theoretical knowledge and practical exercises, students will develop the skills necessary to generate creative ideas, solve complex design problems, and bring their concepts to life.

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2. Course Objectives:

1. Understand the Fundamentals of Product Design and Innovation
2. Apply Design Thinking Principles
3. Conduct Effective Research and Analysis
4. Develop Prototypes and Iterate Designs
5. Manage the Product Development Process
6. Present and Communicate Design Ideas

3.Syllabus

Unit-I: Introduction

Need for design creativity – creative thinking for quality – essential theory about directed creativity

Unit-II: Mechanism of Thinking and Visualization

Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking - Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, colour symmetry. Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking

Unit-III: Creativity

Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation the Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management

Unit-IV: Design

Process Design, Emotional Design – Three levels of Design – Visceral, Behavioural and Reflective- Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management

Unit-V: Innovation

Achieving Creativity – Introduction to TRIZ methodology of Inventive Problem Solving - the essential factors – Innovator's solution – creating and sustaining successful growth – Disruptive Innovation model – Segmented Models – New market disruption - Commoditation and DE-commoditation – Managing the Strategy Development Process – The Role of Senior Executive in Leading New Growth – Passing the Baton

Text Books:

1. Donald A. Norman," Emotional Design", Perseus Books Group New York, 2004

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2. Geoffrey Petty," how to be better at Creativity", The Industrial Society 1999
Reference Books:
6. Clayton M. Christensen Michael E. Raynor," The Innovator's Solution", Harvard Business School Press Boston, USA, 2003 7. Semyon D. Savransky," Engineering of Creativity – TRIZ", CRC Press New York USA," 2000 8. Rousing Creativity: Think New Now, Floyd Hurr, ISBN 1560525479, Crisp Publications Inc. 1999

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME601.1	(Understand) Understand the various techniques adopted for stimulating creativity and innovation
R19ME601.2	(Apply) Apply the techniques to the design and development of new products
R19ME601.3	(Analyze) Identify and analyse the product design and development processes in the manufacturing industry.
R19ME601.4	(Apply) Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
R19ME601.5	(Apply) Use the Product Design and Development Process, as a means to manage the development of an idea from concept through to production.

R19ME602	**3D Printing and Tooling**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description:					
This course provides an in-depth exploration of 3D printing technologies and their applications in modern tooling and manufacturing processes. Students will gain a comprehensive understanding of additive manufacturing techniques, materials used in 3D printing, and the design considerations necessary for creating functional and efficient tools. The course combines theoretical knowledge with hands-on experience, enabling students to design, print, and evaluate 3D-printed components. Key topics include CAD modelling, the operation of 3D printers, post-processing techniques, and the integration of 3D printing into traditional manufacturing workflows.					
2. Course Objectives:					
1. Understand the Fundamentals of 3D Printing					

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2. Apply design principles that take into account the limitations and advantages of 3D printing, such as support structures, layer orientation, and material properties.
3. Understand the properties of various 3D printing materials, including plastics, metals, and composites.
4. Apply post-processing methods such as sanding, painting, and annealing to improve the quality and functionality of 3D-printed parts.
5. Analyze the benefits and challenges of integrating 3D printing into existing manufacturing workflows.

3.Syllabus

Unit-I: Introduction

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes- Applications.

Unit-II: Reverse Engineering and CAD Modelling

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wireframe, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation Software for AM- Case studies.

Unit-III: Liquid Based and Solid Based Additive Manufacturing Systems

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies

Unit-IV: Powder Based Additive Manufacturing Systems

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

Unit-V: Tooling

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics industries.

Text Books:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.

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2. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

Reference Books:

1. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003
2. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A toolbox for prototype development", CRC Press, 2011.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME602.1	(Understand) Understand the history, concepts and terminology of additive manufacturing
R19ME602.2	(Apply) Apply the reverse engineering concepts for design development
R19ME602.3	(Understand) Understand the variety of additive manufacturing techniques
R19ME602.4	(Apply) Design and develop newer tooling models
R19ME602.5	(Analyze) Analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

		L	T	P	C
R19ME603	**Quality Management**	3	0	0	3

1.Course Description:

This course provides a comprehensive overview of quality management principles, practices, and methodologies. Students will explore the concepts and tools necessary to ensure quality in products and services, focusing on both theoretical foundations and practical applications. Topics covered include the history and evolution of quality management, key quality frameworks and standards (such as ISO 9001), statistical quality control, Six Sigma, and Total Quality Management (TQM). Through case studies, real-world examples, and hands-on projects, students will learn how to implement quality management systems and continuous improvement initiatives to enhance organizational performance.

2. Course Objectives:

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1. Trace the historical development of quality management and its key contributors.
2. Develop and implement quality management systems (QMS) in organizational settings.
3. Utilize various tools such as Pareto charts, cause-and-effect diagrams, and flowcharts to identify and solve quality issues.
4. Implement process improvement strategies to enhance efficiency and effectiveness.
5. Develop strategies to improve customer satisfaction and loyalty.
6. Implement best practices from different quality standards to improve organizational performance.

3.Syllabus

Unit-I: Introduction

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention.

Unit-II: TQM Principles

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

Unit-III: TQM Tools And Techniques I

The seven traditional tools of quality - New management tools - Six Sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Benchmarking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

Unit-IV: TQM Tools And Techniques II

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Unit-V: Quality Management System

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration- Environmental Management System: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

Text Books:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.

Reference Books:

1. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. ISO 9001-2015 standards

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME603.1	(Understand) Acquire the basic concepts of total quality management and contributions by Deming, juran and Crossby.
R19ME603.2	(Understand) Acquire the knowledge of total quality management principles and apply the same in manufacturing and service organizations
R19ME603.3	(Apply) Explain the various tools and techniques of total quality management and solve various quality-related problems.
R19ME603.4	(Apply) Explain the various tools and techniques and apply the concepts of Six Sigma in the manufacturing &service sectors.
R19ME603.5	(Apply) Apply ISO 9000-2000 & ISO 14000 quality systems in a product and service organization.

R19ME604	Enterprise Resource Planning	L	T	P	C
		3	0	0	3

1.Course Description:

This course offers a comprehensive understanding of Enterprise Resource Planning (ERP) systems and their role in integrating various business processes across an organization. Students will learn about the core components of ERP systems, including modules for finance, human resources, supply chain management, and customer relationship management. The course covers the selection, implementation, and management of ERP systems, as well as the challenges and best practices associated with ERP projects. Through case studies, practical exercises, and real-world examples, students will gain the skills necessary to effectively utilize ERP systems to improve organizational efficiency and decision-making.

2. Course Objectives:

1. Define ERP and explain its purpose and importance in modern organizations.
2. Understand the technological advancements that have shaped ERP systems.

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3. Map out key business processes and identify how they are integrated within an ERP system. 4. Develop criteria for selecting the appropriate ERP system for an organization. 5. Learn best practices for project management, including risk management and change management. 6. Understand the future direction of ERP systems and their potential impact on businesses.
3.Syllabus
Unit-I: Enterprise Resource Planning
Principle – ERP framework – Business Blue Print – Business Engineering vs Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models.
Unit-II: Technology and Architecture
Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.
Unit-III: ERP System Packages
SAP, People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.
Unit-IV: ERP Architecture
Overview – Architecture – AIM – applications – Oracle SCM.SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET
Unit-V: ERP Procurement Issues
Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.
Text Books:
1. ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999 2. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
Reference Books: 1. Jose Antonio Fernandez, The SAP R/3 Handbook, Tata Mcgraw Hill, 1998. 2. Thomas E Vollmann and BeryWhybark, Manufacturing and Control Systems, Galgothia Publications, 1998. 3. Vinod Kumar Crag and N.K.Venkitakrishnan, Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME604.1	(Understand) Provide an integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
R19ME604.2	(Understand) Understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
R19ME604.3	(Apply) Become aware of the software applications and tools that are available to business to use to drive out costs and improve efficiency.
R19ME604.4	(Apply) Identify the important business functions provided by typical business software such as enterprise resource planning and customer relationship management
R19ME604.5	(Analyze) Develop skills necessary for building and managing relationships with customers, and stakeholders.

R19ME605	Micro Electro Mechanical Systems	L	T	P	C
		3	0	0	3

1.Course Description:

This course explores MEMS and Microsystems, covering materials, working principles, mechanics, scaling laws, design considerations, fabrication processes (including photolithography and micromachining), packaging technologies, and micrometrology techniques. Emphasis is on integrating theory with practical applications across various industries.

2. Course Objectives:

1. Understand MEMS materials and fabrication techniques to design microsystems for diverse applications.
2. Learn scaling laws and engineering principles to optimize the design and performance of MEMS devices.
3. Implement advanced micromachining processes for precise fabrication of microstructures.
4. Understand packaging technologies to ensure reliability and functionality of microsystems.
5. Utilize micro metrology tools for accurate characterization and analysis of MEMS components.

3.Syllabus

Unit-I: Introduction

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Overview of MEMS and Microsystems: MEMS and Microsystems, Evolution of Microfabrication, Microsystems and Microelectronics, Microsystems and miniaturization-Materials for MEMS and Microsystems: substrates and wafers, active substrate materials, Silicon, Gallium Arsenide, Piezoelectric Crystals, Polymers, Packaging materials-Working principles of Microsystems: micro sensors, micro actuation, MEMS with microactuators, Micro accelerometers, micro fluidics-Applications of Microsystems in various industries.
Unit-II: Mechanics, Scaling and Design
Engineering Mechanics for Microsystems design: Introduction, Static bending of Thin Plates, Mechanical Vibration, Thermomechanics, Thermofluid, Engineering and microsystem design, Laminar fluid flow, Incompressible fluid Flow, Heat conduction in solids-scaling Laws in Miniaturization, Introduction to scaling, Scaling in (Electrostatic forces electromagnetic forces, Electricity, fluid mechanics, heat transfer)-Microsystems Design: Design Consideration, Process design, Mechanical Design, Design of Micro fluidic Network systems
Unit-III: Micro System Fabrication Processes
Introduction: Photolithography, Ion implantation; Chemical Vapour Deposition, Physical Vapour Deposition; Bulk micromachining : etching, isotropic and anisotropic etching, wet and dry etching- Surface micro machining :process, mechanical problems associated with surface micro machining; LIGA process: General description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining-Micro Electrical Discharge Micro Machining –Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining
Unit-IV: Microsystems Packaging
Introduction: Microsystems Packaging, Interfaces in Microsystems Packaging, Essential Packaging Technologies; Die preparation, surface bonding, wire bonding, sealing; Three-dimensional Packaging, Assembly of Microsystems, Signal Mapping and Transduction
Unit-V: Micro metrology And Characterization
Microscopy and visualization, Lateral and vertical dimension, optical microscopy, Scanning white light interferometry; Confocal Laser scanning microscopy, Molecular measuring machine; Micro coordinate measuring machine: Electrical measurements, Physical and chemical analysis – XRD, SEM; Secondary Ion mass spectrometry: Auger Electron Spectroscopy, SPM
Text Books:
3. Franssila, S., "Introduction to Micro Fabrication" John Wiley & sons Ltd, 2004.ISBN:470- 85106-6 4. Hsu, T.R., "MEMS & Microsystems Design and Manufacture", Tata McGraw Hill, 2002, ISBN: 9780070487093

5. Hak M.G., "MEMS Handbook", CRC Press, ISBN: 8493-9138-5, 2006. 6. Jackson, M.J., "Microfabrication and Nanomanufacturing" Taylor and Francis 2006.
Reference Books:
1. Jain, V.K., "Introduction to Micromachining" Narosa Publishing House, 2010. 2. McGeough, J.A., "Micromachining of Engineering Materials", CRC Press, ISBN: 0824706447, 2001.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME605.1	Use mechanics principles to analyze the mechanical performance of microsystems.
R19ME605.2	Be familiar with the tools and processes used in micromachining of microelectromechanical systems (MEMS).
R19ME605.3	Explain MEMS technology, present, future and challenges.
R19ME605.4	Explain micro sensors, micro-actuators, their types and applications.
R19ME605.5	Explain about fabrication processes for producing micro-sensors and actuators.

R19ME606	**Quality Control Tools and Techniques**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

This course covers fundamental concepts of quality management, including quality dimensions, control charts for variables and attributes, statistical process control techniques, acceptance sampling methods, and their applications in ensuring product and process quality in various industrial contexts.

2. Course Objectives:

1. Understand the evolution and importance of quality concepts in industrial practices.
2. Implement control charts for variables to monitor and improve process performance.
3. Learn statistical process control methods to enhance process stability and capability.
4. Apply control charts for attributes to minimize defects and non-conformities in production.
5. Learn the acceptance sampling techniques for efficient quality assurance and compliance with standards.

3.Syllabus

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Unit-I: Quality Fundamentals
Importance of quality; evolution of quality; definitions of quality; dimensions of quality; quality control: quality assurance, areas of quality, quality planning; quality objectives and policies; quality costs, economics of quality; Quality loss function: Quality Vs Productivity, Quality Vs reliability
Unit-II: Control Charts For Variables
Process variation preliminary decisions, control limits and their computation; construction and application of X bar, R and S charts; Warning and modified control limits; process adjustment for trend; Comparison of process variation with specification limits; O.C. curve for X bar chart.
Unit-III: Statistical Process Control
Process stability: process capability study using control charts, capability indices; Cp, Cpk and Cpm; capability analysis using histogram and normal probability plot; machine capability study: gauge capability study, setting statistical tolerances for components and assemblies-individual measurement charts: X-chart, moving average and moving range chart, multi-variable chart.
Unit-IV: Control Charts for Attributes
Limitations of variable control charts, Control charts for fraction non-conforming; p and np charts; variable sample size; operating characteristic function, run length; Control chart for nonconformities (defects) c, u, ku charts, demerits control chart, applications.
Unit-V: Acceptance Sampling
Need, Economics of sampling, sampling procedure, single and double sampling, O.C. curves; Average outgoing quality, Average sample number, Average total inspection, Multiple and sequential sampling, Standard sampling plans; MIL Standards, Dodge, Roming; IS 2500.
Text Books:
1. Douglus C. Montgomery, "Introduction to Statistical Quality Control", Wiley-India, Seventh Edition, 2013. 2. Krishnaiah K.," Applied Statistical Quality Control and Improvement", PHI, 2014. 3. AmitavaMitra, "Fundamentals of Quality Control and Improvement", Wiley, Third Edition, 2008.
Reference Books: 1. Dale H. Besterfield, Quality Control, Pearson Education Asia, Eighth Edition, 2008. 2. Eugene L. Grant and Richard S. Leaven Worth, "Statistical Quality Control", McGraw-Hill Education, Seventh Edition, 2000.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME606.1	Familiar with details of quality costs, economies and planning
R19ME606.2	Control the quality of processes using control charts for variables in manufacturing/service industries.
R19ME606.3	Good understanding and in depth knowledge have been imparted in the process capability study.
R19ME606.4	Control the occurrence of defects in product or service industries
R19ME606.5	Determine the acceptance sampling procedures that are practised.

		L	T	P	C
R19ME607	**World Class Manufacturing**	**3**	**0**	**0**	**3**

1.Course Description:

This course examines industrial trends from decline to resurgence, emphasizing manufacturing excellence across regions. It explores customer-focused principles, value assessment, strategic linkages, and identifies impediments in operational effectiveness, providing insights into achieving stability and competitiveness in global markets.

2. Course Objectives:

1. Understand and evaluate the historical and global trends in industrial decline and ascendancy, focusing on manufacturing excellence across different regions and decades.
2. Develop and apply customer-focused principles in design, operations, human resources, quality, and marketing to enhance organizational effectiveness.
3. Understand and assess the importance of product costing, enterprise quality, and organizational stability, including the roles of individual and team contributions to overall project cohesiveness.

3.Syllabus

Unit-I: Industrial Decline and Ascendancy

Manufacturing excellence: US Manufacturers, French Manufacturers; Japan decade; American decade; Global decade.

Unit-II: Building Strength through Customer – Focused Principles

Customer; Focused principles; General principles: Design, Operations, Human resources; Quality and Process improvement; Promotion and Marketing. .

Unit-III: Value and Valuation

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Product Costing: Motivation to improve, Value of the enterprises QUALITY; The Organization: Bulwark of stability and effectiveness; Employee stability; Quality Individuals Vs. Teams; Team stability and cohesiveness; Project cohesiveness and stability
Unit-IV: Strategic Linkages
Product decisions and customer service; Multi-company planning; Internal manufacturing planning; Soothing the demand turbulence.
Unit-V: Impediments
Bad plant design; Mismanagement of capacity, Production Lines, Assembly Lines; Whole Plant Associates: Facilitators, Teams Manship; Motivation and reward in the age of continuous Improvement.
Text Books:
1. By Richard B. Chase, Nicholas J. Aquilano, F. Robert Jacobs – "Operations Management for Competitive Advantage", McGraw-Hill Irwin, ISBN 0072323159 2. Moore Ran, "Making Common Sense Common Practice: Models for Manufacturing Excellence", Elsevier Multiworth
Reference Books: 1. Narayanan V. K., "Managing Technology & Innovation for Competitive Advantage", Pearson Education Inc 2. Korgaonkar M. G., "Just In Time Manufacturing", MacMillan Publishers India Ltd., 3. Sahay B. S., Saxena K. B. C., Ashish Kumar, "World Class Manufacturing", MacMillan Publishers

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME607.1	Understand the concept and the importance of manufacturing strategy for industrial enterprise competitiveness.
R19ME607.2	Apply appropriate techniques in the analysis an devaluation of company's opportunities for enhancing competitiveness in the local regional and global context.
R19ME607.3	Identify formulation and implement strategies for manufacturing and therefore enterprise competitiveness.
R19ME607.4	Analyzing how World Class Manufacturing technique can create value generation for organization.
R19ME607.5	Apply smart techniques to bring competitive business culture for improving organization performance

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R19ME608	Industrial Safety Engineering	L	T	P	C
		3	0	0	3

1.Course Description:

This course covers industrial safety, maintenance engineering, wear and corrosion prevention, fault tracing, and periodic/preventive maintenance. It includes accident causes and control, safety regulations, maintenance strategies, lubrication methods, fault detection, and preventive maintenance procedures, ensuring comprehensive understanding of maintaining and improving industrial equipment and workplace safety.

2. Course Objectives:

1. Identify and control industrial hazards to ensure workplace safety and compliance with safety regulations.
2. Implement maintenance strategies for efficient operation and longevity of industrial equipment.
3. Apply fault tracing techniques to diagnose and resolve issues in various industrial systems

3.Syllabus

Unit-I: Industrial Safety

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Unit-II: Maintenance Engineering

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit-III: Wear and Corrosion and their prevention

Wear: types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications: i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication; Definition, principle and factors affecting the corrosion; Types of corrosion; corrosion prevention methods.

Unit-IV: Fault Tracing

Fault tracing: concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like: i. Any one

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machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors; Types of faults in machine tools and their general causes.

Unit-V: Periodic and Preventive Maintenance

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

Text Books:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
3. Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
4. Garg, HP, Maintenance Engineering, S. Chand Publishing.

Reference Book:

1. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME608.1	(Apply)Explain the fundamental concept and principles of industrial safety
R19ME608.2	(Apply)Apply the principles of maintenance engineering.
R19ME608.3	(Analyze)Analyze the wear and its reduction.
R19ME608.4	(Evaluate)Evaluate faults in various tools, equipment and machines.
R19ME608.5	(Apply)Apply periodic maintenance procedures in preventive maintenance

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R19ME609	Introduction to Industry 4.0	L	T	P	C
		3	0	0	3

1.Course Description:

Introduction to Industry 4.0 covers the fundamentals of road to Industry 4.0, related Disciplines, System, Technologies, role Of Data, Information, Knowledge and Collaboration in Future Organizations and Business Issues in Industry 4.0.

2. Course Objectives:

1. To study the basics of Industrial Revolution
2. To study the basic concepts of Industry 4.0
3. To study the Concepts of related disciplines, system, technologies for enabling industry 4.0
4. To study the role of data, information, knowledge and collaboration in future organizations
5. To analyse the Business issues in Industry 4.0

3.Syllabus

Unit-I: Introduction to Industry 4.0

The Various Industrial Revolutions, Digitalization and the Networked Economy: Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0; The Journey so far: Developments in USA, Europe, China and other countries; Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

Unit-II: Road to Industry 4.0

Internet of Things (IoT), Industrial Internet of Things (IIoT) and Internet of Services; Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities and Predictive Analytics.

Unit-III: Related Disciplines, System, Technologies for Enabling Industry 4.0

Big data, Physical Systems, Robotic Automation and Collaborative Robots; Support System for Industry 4.0: Mobile Computing, Artificial intelligence and Machine learning, Cyber Security, Digital twin, Digital thread, PLM, Augmented reality and Virtual Reality.

Unit-IV: Role of Data, Information, Knowledge and Collaboration In Future Organizations

Resource: based view of a firm, Data as a new resource for organizations; Harnessing and sharing knowledge in organizations: Cloud Computing Basics, Cloud Computing and Industry 4.0.

Unit-V: Business Issues in Industry 4.0

Opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era; Strategies for competing in an Industry 4.0 world: legacy, social issues and their solutions.

Text Book:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A press, 2016.

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Reference Books:
1. "The Fourth Industrial Revolution" by Klaus Schwab, World Economic Forum 2. "Internet of Things: A Hands-On Approach" by Arsheep Bahga and Vijay Madisetti, University Press 3. NOC: Introduction to Industry 4.0 and Industrial Internet of Things

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME609.1	(Understand) Understand the basics of Industrial Revolution
R19ME609.2	(Understand) Understand the basic concepts of Industry 4.0
R19ME609.3	(Understand) Understand the Concepts of related disciplines, system, and technologies for enabling Industry 4.0
R19ME609.4	(Understand) Understand the role of data, information, knowledge and collaboration in future organizations
R19ME609.5	(Analyze) Analyze the Business issues in Industry 4.0

R19ME610	Lean Six Sigma and Supply Chain Management	L	T	P	C
		3	0	0	3

1.Course Description:

This course integrates Lean Six Sigma principles into supply chain management, focusing on waste reduction, process optimization, quality improvement, and achieving operational excellence through practical tools and project-based learning.

2. Course Objectives:

1. To integrate Lean principles (waste reduction) and Six Sigma methodologies (defect reduction) to optimize supply chain processes.
2. To apply tools like Value Stream Mapping and DMAIC (Define, Measure, Analyze, Improve, Control) to streamline supply chain operations.
3. To implement Six Sigma practices to enhance product and service quality, reduce defects, and improve overall efficiency.
4. To create a culture of continuous improvement and operational excellence throughout the supply chain.
5. To engage in practical projects to apply Lean Six Sigma concepts in real-world supply chain scenarios, emphasizing measurable outcomes and sustainable improvements.

3.Syllabus

Unit-I: Introduction to Lean And Six-Sigma

Introduction to Lean: Definition, Purpose, features of Lean; top seven wastes, Need for Lean, Elements of Lean Manufacturing, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six-sigma, origin of six-sigma, six-sigma concept, and Critical success factors for six-sigma. Evolution of lean six-sigma, the synergy of Lean and six sigma, Definition of lean six-sigma, the principles of lean six-sigma, Scope for lean six sigma, Features of lean six sigma, the laws of lean six-sigma, Benefits of lean six-sigma.
Unit-II: Tools for Lean Six- Sigma
Define tools, Project Definition Form(PDF) and SIPOC; Measure tools: Process mapping, Parato chart, cause and effect matrix, FMEA, Brain-storming, NGT, Multi-voting, Cause & Effect diagram, Check sheets, Gauge R&R, Run charts, Control charts and process capability analysis; Analyze tools: scatter plots, ANOVA, Regression analysis and time trap analysis; Improve tools: Mistake proofing, KAIZEN, Reducing congestions and delays, SMED, TPM, Design of Experiments and the pull system; Control tools: SPC.
Unit-III: Design for Lean Six-Sigma
Predicting and improving team performance, nine team roles, Team leadership, Team building & Team exercise. DMAIC process and toll gate reviews, Need for institutionalizing Lean Six- Sigma, Comply, commit, embed and encode; Steps in institutionalizing the Lean Six- Sigma; Objectives of Design for Lean Six-Sigma, Improving design velocity, Reducing product line complexity, Design for Lean Six-Sigma-QFD,TRIZ, Robust design.
Unit-IV: Concepts of Supply Chain
Service and manufacturing supply chain dynamics, Evolution of supply chain management, Multiple views and flows, Service supply chains, Manufacturing supply chains, Measures of supply chain performance, Differentiation, Bullwhip effect.
Unit-V: Supply Chain Processes and Strategies
Integrated supply chains design, Customer relationship process, Order fulfilment process, Supplier relationship process, Supply chain strategies, Strategic focus, Mass customization, Lean supply chains, Outsourcing and offshoring, Virtual supply chains.
Text Books:
1. Michael L. George, Lean Six Sigma, McGraw-Hill, 2002. 2. Sunil Chopra Peter Meindl, D.V.Kalra," Supply chain management", Pearson Education, Prentice Hall of India, 2010.
Reference Books:
1. Forrest W. Breyfogle III, Implementing Six Sigma: Smarter Solutions Using Statistical Methods, 1999. 2. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2003.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

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CO. No.	Course Outcome
R19ME610.1	(Understand) Understand issues & challenges in implementing & developing lean manufacturing techniques from TPS & its contribution.
R19ME610.2	(Apply) Apply lean techniques to bring competitive business culture for improving organization performance.
R19ME610.3	(Analyze) Analyze how lean techniques can be applied to the manufacturing & service industry.
R19ME610.4	(Apply) Developing lean management strategy for Supply chain management.
R19ME610.5	(Analyze) Analysing how lean technique can create value generation for organization.

R19ME611	**Business Organization and Development**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1.Course Description:

This course focus on understanding structures, strategic planning, organizational effectiveness, entrepreneurship, legal compliance, financial management, market analysis, growth strategies, risk management, and global business dynamics.

2. Course Objectives:

1. To understand various business structures and their implications for operations and governance.
2. To develop skills in formulating and implementing business strategies aligned with organizational goals.
3. To explore methods to enhance leadership, team dynamics, and adaptability within organizations.
4. To study the principles of entrepreneurship, fostering innovation, and seizing business opportunities.
5. To understand legal requirements and ethical considerations in business operations, emphasizing compliance and responsible corporate conduct.

3.Syllabus

Unit-I: Business Environment

Nature and purpose of business, classification of business activities: industry, commerce and trade, objective of business and essential of successful business, economic environment: basic problems of scarcity and choice, allocation of resources, opportunity cost; Business growth and measurement of size ,International Environment-balance of trade ,the trade gap ,and balance of payments, role and methods of trade protectionism, Business Ethics.

Unit-II: Business Structure and Organization

Historical view of business development forms of business organization: sole proprietorship, partnership, join stock companies, co-operative societies, public enterprise, Definition,

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Meaning, characteristics, Advantages and Disadvantages; Role of Government in business activity, organization charts.
Unit-III: Elements of Business Activity
Purchasing: choosing suppliers, overview of stock control, production-scale of production, main features of job, mass and batch production systems; Marketing: concept and role of marketing, marketing mix, channels of distribution; Finance: sources of finance, assessing business performance.
Unit-IV: Human Resources
Demographic trends and their impact on business concerns; Unemployment: effects and types of unemployment; Local trends in employment in various sectors, selection, recruitment, training of workers, motivation, basic knowledge of working age, contract of work, minimum wage, statutory hours of work, statutory benefits.
Unit-V: Foreign Trade and Banking
Foreign trade: meaning, nature, importance, procedure of export and import, globalization, MNC, MNE; Introductory idea about commercial banks: functions and services; Insurance: meaning, types, principles, benefits.
Text Books:
1. Joel Dean - Managerial Economics, Prentice Hall/Pearson, 2007. 2. Rangarajan - Principles of Macro Economics, Tata McGraw Hill
Reference Books: 1. Marketing Management - Philip Kotler - Pearson Education- Millennium Edition 2. Gary Dessler, "Human Resource Management", Seventh edition, Prentice-Hall of India P.Ltd., Pearson

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME611.1	(Understand) Explain the basic fundamentals of the business environment, organisational theory and marketing, including capacity to recognise and use relevant terminology
R19ME611.2	(Understand) Read, understand and critically evaluate the information contained in relevant academic texts.
R19ME611.3	(Understand) Organise and present information to a satisfactory standard in oral presentations, essays and reports.
R19ME611.4	(Understand) Give an idea about organisation structure and different types of organisations
R19ME611.5	(Understand) Provide idea about motivation, importance of foreign trade and Principles of coordinating the import and export

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R19ME612	Product Distribution and Promotion Management	L	T	P	C
		3	0	0	3

1.Course Description:

This course focuses on developing strategies for efficient product distribution through effective channel management and logistics. It also covers promotional techniques like advertising and digital marketing to maximize product visibility and sales effectiveness.

2. Course Objectives:

1. To develop effective distribution channels and logistics plans to optimize product flow and reach target markets.
2. To study the various methods including advertising, sales promotions, and digital marketing to enhance product visibility and consumer engagement.
3. To identify and target specific customer segments to tailor distribution and promotional strategies accordingly.
4. To understand how to manage relationships with distributors and retailers to ensure efficient product placement and availability.
5. To provide sales teams with the necessary tools and strategies to effectively promote and sell products in diverse market environments.

3.Syllabus

Unit-I: Introduction

Marketing: Definitions, Conceptual frame work; Marketing environment: Internal and External; Marketing interface with other functional areas: Production, Finance, Human Relations Management, Information System; Marketing in global environment: Prospects and Challenges.

Unit-II: Product Distribution Strategy

Marketing strategy formulations, Key Drivers of Marketing Strategies; Strategies for Industrial Marketing: Consumer Marketing, Services marketing; Competitor analysis: Analysis of consumer and industrial markets; Strategic Marketing Mix components.

Unit-III: Marketing Mix Decisions

Product planning and development, Product life cycle; New product Development and Management: Market Segmentation, Targeting and Positioning, Channel Management; Advertising and sales promotions: Pricing Objectives, Policies and methods.

Unit-IV: Buyer Behaviour

Understanding industrial and individual buyer behaviour, influencing factors; Buyer Behaviour Models: Online buyer behaviour; Building and measuring customer satisfaction: Customer relationships management, Customer acquisition, Retaining, Defection.

Unit-V: Marketing Research & Trends in Marketing

Marketing Information System; Research Process, Concepts and applications: Product, Advertising, Promotion, Consumer Behaviour; Retail research, Customer driven organizations, Cause related marketing, Ethics in marketing, Online marketing trends.

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Text Books:
1. Philip Kotler and Kevin Lane Keller, Marketing Management, PHI 14th Edition, 2012 2. KS Chandrasekar, "Marketing management-Text and Cases", Tata McGraw Hill, First edition,2010
Reference Books:
1. Lamb, hair, Sharma, Mc Daniel– Marketing – An Innovative approach to learning and teaching-A South Asian perspective, Cengage Learning — 2012 2. Paul Baines, Chris Fill and Kelly Page, Marketing, Oxford University Press, 2nd Edition,2011.

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME612.1	(Understand) Understand the concepts of marketing management
R19ME612.2	(Understand) Learn about marketing process for different types of products and services
R19ME612.3	(Understand) Understand the tools used by marketing managers in decision situations
R19ME612.4	(Understand) Understand the marketing environment
R19ME612.5	(Understand) Demonstrate effective understanding of relevant functional areas of marketing management and its application.

		L	T	P	C
R19ME613	**Business Ethics, Corporate Social Responsibilities and Governance**	3	0	0	3

1.Course Description:
The course aims to enhance understanding of ethical decision-making, integrate corporate social responsibility into business practices, explore governance principles, engage stakeholders effectively, and ensure legal compliance in organizational operations.
2. Course Objectives:
1. To develop awareness of ethical issues and dilemmas in business contexts, and learn frameworks for ethical decision-making. 2. To understand the importance of CSR, and learn strategies to integrate ethical practices into business operations. 3. To explore corporate governance structures, roles, and responsibilities of boards, and practices for transparency and accountability.

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4. To study the methods to effectively engage and manage relationships with stakeholders, considering their interests and expectations.
5. To understand legal frameworks related to ethics, CSR, and governance, ensuring adherence to regulations and ethical standards in business practices.

3.Syllabus

Unit-I: Introduction

Definition & nature Business ethics, Characteristics, Ethical theories; Causes of unethical behavior; Ethical abuses; Work ethics; Code of conduct; Public good.

Unit-II: Ethics Theory and Beyond

Management of Ethics - Ethics analysis [Hosmer model]; Ethical dilemma; Ethics in practice-ethics for managers; Role and function of ethical managers- Comparative ethical behaviour of managers; Code of ethics; Competitiveness, organizational size, profitability and ethics; Cost of ethics in Corporate ethics evaluation. Business and ecological / environmental issues in the Indian context and case studies.

Unit-III: Legal Aspects of Ethics

Political – legal environment; Provisions of the Indian constitution pertaining to Business; Political setup – major characteristics and their implications for business; Prominent features of MRTP & FERA. Social – cultural environment and their impact on business operations, Salient features of Indian culture and values

Unit-IV: Environmental Ethics

Economic Environment; Philosophy of economic grow and its implications for business, Main features of Economic Planning with respect to business; Industrial policy and framework of government contract over Business; Role of chamber of commerce and confederation of Indian Industries.

Unit-V: Corporate Social Responsibility and Governance

Definition- Evolution- Need for CSR; Theoretical perspectives; Corporate citizenship; Business practices; Strategies for CSR; Challenges and implementation; Evolution of corporate governance; Governance practices and regulation; Structure and development of boards; Role of capital market and government; Governance ratings; Future of governance-innovative practices; Case studies with lessons learnt.

Text Books:

1. Robert A.G. Monks and Nell Minow, Corporate governance, John Wiley and Sons, 2011.
2. William B. Werther and David B. Chandler, Strategic corporate social responsibility, Sage Publications Inc., 2011

Reference Books:

1. S.A. Sherlekar, Ethics in Management, Himalaya Publishing House, 2009.
2. Beeslory, Michel and Evens, Corporate Social Responsibility, Taylor and Francis, 1978.

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4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19ME613.1	(Understand) Students will be able to explain the concept of business ethics, its necessity, and its role in contemporary business.
R19ME613.2	(Understand) Students will understand and apply ethical theories like utilitarianism, deontology, and virtue ethics to real-world business dilemmas.
R19ME613.3	(Analyze) Learners will analyse examples of ethical abuses and their impact on business and society, providing insights into avoiding such practices.
R19ME613.4	(Understand) Students will understand the significance of maintaining strong work ethics and adhering to a company's code of conduct.
R19ME613.5	(Apply) Learners will explore different theoretical perspectives on CSR and how they apply to business practices.

R19PH601	**Laser Technology**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

Laser technology course is designed to offer engineering students with a sturdy base in the field of laser incorporating its basic principles and its potential applications in various fields.

2. Course Objectives:

1. Facilitating the students to restate the basics of lasers, characteristics and their types.
2. To build knowledge on basics of holography and its applications.
3. Encouraging the students to gain a comprehensive understanding on the applications of laser in industries.
4. Assisting the learners in gaining exposure on the medicinal applications of laser.
5. Helping students acquaint themselves with atmospheric applications.

3. Syllabus

Unit-I: Foundation to Laser and its Types

Introduction to laser - Requirements for obtaining population inversion - 2,3 and 4 level systems: Pumping schemes - Threshold gain coefficient - Ruby laser - Nd:YAG laser - He-Cd laser - X-ray laser - Carbon dioxide laser - Semiconductor laser: Homojunction and Hetrojunction lasers - Liquid lasers - Dye laser - Quantum well laser - Free electron Lasers - Fiber Lasers.

Unit-II: Holography

Holography: Basic Principle - Holography vs. photography - Principle of Hologram Recording - Condition For Recording - A hologram - Holographic components - Construction and Reconstruction of a hologram - Viewing the holographic image - Holography for non-destructive testing (HNDT) - Speckle Non Destructive Testing (SNDT) - Optical disk storage.

Unit-III: Industrial Applications

Laser parameters for welding, drilling, cutting: Dependence of wavelength, pulse width, repetition rate, modulation and gas shielding factors influencing the parameters - Recent

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developments - Hybrid welding - Cooling parameters for welding processes - Advantages of laser processing versus conventional methods.
Unit-IV: Medical Applications
Laser and tissue interaction - Medical applications of lasers: Dermatology - Plastic surgery - Wound healings - Nerve stimulation - Dentistry - Ophthalmology - Laser instruments for surgery - Removal of tumours of vocal cards - Brain surgery - Gynaecology Oncology - Cancer diagnosis and therapy - Laser safety fundamentals - Basic laser tweezers.
Unit-V: Metrological Applications
Interferometric techniques - Calibration Methods - LIDARS - Theory and different experimental arrangements - Pollution monitoring by remote sensing - Applications - Laser gyroscope.
Text Books:
1. Nambiar, K.R., "Laser Principles, Types & Applications", New Age International, 2004. 2. Duley,W.W., "Laser Processing and Analysis of Materials", Plenum Press, New York,1983. 3. Ghatak, A.K., Thyagarajan, K., "Lasers: Theory and Applications", McMillan, 2003.
References:
Reference Books: 1. Thyagarajan, K., Ghatak,A., "Lasers: Fundamentals and Applications", Springer, 2012. 2. Nityanand Choudhary, RichaVerma, "Laser Systems and Applications", PHI Learning Private Ltd, 2011. 3. Nagabhushana, S., Sathyanarayana B., "Lasers and Optical Instrumentation", I.K. International Publishing House Pvt. Ltd, 2010. 4. KoechnerW., "Solid State Laser Engineering", Springer Series in Optical Sciences, Vo.1, Springer Verlag **Journals:** 1. https://www.sciencedirect.com/journal/optics-and-laser-technology 2. https://www.hilarispublisher.com/lasers-optics-photonics.html **Video References:** 1. https://www.youtube.com/watch?v=XkU9jWg49rg 2. https://archive.nptel.ac.in/courses/104/104/104104085/ 3. https://ocw.mit.edu/courses/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/resources/laser-fundamentals-i/ **MOOC/NPTEL/SWAYAM Courses:** 1. https://archive.nptel.ac.in/courses/115/102/115102124/ 2. https://onlinecourses.nptel.ac.in/noc22_me92/preview 3. https://onlinecourses.nptel.ac.in/noc20_cy17/preview

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4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19PH601.1	Realize the fundamentals of lasers, laser systems, their characteristics and types.
R19PH601.2	Acquire knowledge on principles of holography and its applications in various fields.
R19PH601.3	Identify and explore the various industrial applications of laser.
R19PH601.4	Gain capabilities to explore the applications of laser in medical field in addition to their safety guidelines.
R19PH601.5	Interpret the knowledge on investigating applications of laser in the atmosphere and its phenomena, including both weather and climate.

R19PH602	**Nanomaterials and Applications**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

Nanomaterials are materials with nanoscale dimensions where the surface or interface properties dominate over the bulk properties. The very large surface area of these nanomaterials can result in novel physical and chemical properties, such as increased catalytic activity, improved solubility, or different optical behavior. Nanomaterials are already found in a wide variety of consumer products, such as textiles, paints, sunscreens, and other healthcare products. Intensive research is being done in the use of nanomaterials for energy storage and energy conversion, pharmaceuticals, life science applications, solar cells, catalysis, and composite materials, to name just a few.

2. Course Objectives:

1. To enable the students to learn the properties of nanomaterials.
2. To prepare the students to understand the concept of different characterization techniques used for analysing the various samples.
3. To enable the students to understand the impact of nanotechnology in the environment.
4. To enable the students to learn the applications of nanomaterials in different sectors.

3. Syllabus

Unit-I: Nanomaterials: Properties and Synthesis

Introduction, quantum confinement: 0D, 1D, 2D & 3D structures; Unique properties of materials, Difference between bulk and nano materials, Synthesis andpreparation of nanomaterials: Sol Gel processing, Micro emulsion, Hydrothermal, Solvo thermal, Microwave assisted synthesis, Organic-Inorganic hybrid nano composites – Quantumdot (QDs) synthesis.

Unit-II: Nanosensors and Nanotubes

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Introduction: Nano sensors, Characteristic and terminology; Nano wire based sensors, Properties and fabrication of nano wires, Nano wires sensors for Gas sensing application, Electron Skin, Field effect transistors, Gold nano particles, Carbon nano tubes: Structure, Properties, Synthesis and applications of CNT – Fullerenes.
Unit-III: Nanomaterials Characterization Techniques
Diffraction analysis: X-ray diffraction, Powder diffraction, Lattice parameters, Structure Analyses, Strain analyses, Phase identification, Particle size analyses using Scherer's formula, X-ray Photoelectron spectroscopy (XPS); Infra-Red spectroscopy (IR); Rotational & Vibrational ;UV-Visible , Raman Spectroscopy; Photo Luminescence (PL), Cathode Luminescence (CL).
Unit-IV: Nanotechnology in Environment
Environmental pollutants in air, water, soil, hazardous and toxic wastes: Water treatment, Drinking water and Air/Gas purifications; The challenge to occupational health and hygiene; Toxicity of nano particles, Effects of inhaled Nano sized particles, Skin exposure to nano particlesHazards and risks of exposure to nano particles, Monitoring nano particles in work place and sensors.
Unit-V: Applications of Nanotechnology
Nanoelectronics, Nanotechnology in Diagnostics, Environmental, Agricultural and food processing, Nanotechnology for energy systems.
Text Books:
1. Sanjay Mathur and Mrityunjay Singh," Nanostructured Materials and Nanotechnology", II Eds., Willey, 2008. 2. S. Vijaya, G.Rangarajan, "Materials Science", M, Tata McGraw Hill publishing company Ltd., NewDelhi, 2003. 3. Geoffrey A. Ozin, Andre C. Arsenault and Ludovico Cademartiri, "Nanochemistry: A Chemical Approach to Nanomaterials", Second New edition, Royal Society of Chemistry, Cambridge UK, 2008.
References:
Reference Books: 1. Schmidt.G ,"Nanoparticles: From theory to applications", Wiley –VCH, 2006. 2. Zhong Lin Wang, Yi Liu and Ze Zhang," Hand Book of Nanophase& Nanostructured materials", Volumes I-IV, Springer,2002. 3. Chaudhery Mustansar Hussain, Ajay Kumar Mishra," Nanotechnology in Environmental Science", Wiley-VCH, 2018. 4. Zishan Husain Khan, "Nanomaterials and Their Applications", Springer, 2018. 5. Kevin C. Honeychurch," Nano sensors for Chemical and Biological Applications" Sensing with Nanotubes, Nanowires and Nanoparticles", Woodhead publishing Ltd., 2014. **Journals:** 1. http://www.aspbs.com/jnn/

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2. https://iopscience.iop.org/journal/0957-4484
3. https://onlinelibrary.wiley.com/journal/8384
4. https://www.nature.com/nnano/
5. https://www.sciencedirect.com/journal/nanomedicine-nanotechnology-biology-and-medicine
6. https://www.sciencedirect.com/journal/environmental-nanotechnology-monitoring-and-management

Video References:

1. https://youtu.be/ebO38bbq0_4?list=PLbMVogVj5nJTdeiLvuGSB_AE8hloTAHWJ
2. https://youtu.be/EABqmh2aDPU
3. https://youtu.be/lFYs3XDu4fQ
4. https://youtu.be/Y32Csnt-1Pw

https://youtu.be/0EWCqCIsFOA?list=PLyqSpQzTE6M8682dGkNTN8936vSY4CbqZ

MOOC/NPTEL/SWAYAM Courses:

1. https://nptel.ac.in/courses/118102003
2. https://onlinecourses.nptel.ac.in/noc19_mm21/preview
3. https://archive.nptel.ac.in/courses/118/107/118107015/
4. https://archive.nptel.ac.in/courses/118/102/118102003/
5. https://archive.nptel.ac.in/courses/118/104/118104008/

4. Course Outcomes

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19PH602.1	Explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
R19PH602.2	Explore the properties of nanotubes and sensors for different applications.
R19PH602.3	Identify the suitable technique for characterization of nanomaterials and devices for various applications.
R19PH602.4	Identify impacts of nano pollutants on environment and E-waste management techniques.
R19PH602.5	Examine the different applications of nanomaterials.

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R19PH603	Physics for Solar PV System	L	T	P	J	C
		3	0	0	0	3

1. Course Description:

This course offers cutting-edge knowledge within the field of photovoltaic system technology. This course is unique and provides the spotlight on the solar resources and how photovoltaic energy conversion can be applied to produce electric power. It incorporates the design and operation of different solar cell, the various photovoltaic system components for various applications.

2. Course Objectives:

1. To impart knowledge on photovoltaic fundamentals and to build solar cells of better efficiency.
2. To offer a blend of technical expertise required for design and operation of a solar photovoltaic systems.
3. To review on the classification of photovoltaics and the components used to apply in various advanced photovoltaic devices.

3. Syllabus

Unit-I: Photovoltaic Fundamentals

Solar radiation, its measurements and analysis - Solar angles- day length, angle of incidence on tilted surface, Sun path diagrams- Shadow determination- P-N junction- homo and hetro junctions. Metal-semiconductor interface. Dark and illumination characteristics - Figure of merits of Solar Cell - Efficiency limits - Variation of efficiency with band-gap.

Unit-II: PV Module Performance

Photovoltaic modules - Solar PV modules from solar cells - Series and parallel connection of cells, mismatch in series connection - Hot spots in module, bypass diode, mismatching in parallel connection. Solar PV Systems - Components: PV array, inverter, energy storage, Performance analysis of solar photovoltaic (PV) Cell - Efficiency of solar cell - Limitation of Solar Cell, Solar module & Solar Array -Solar power plant battery, Inverter, system charge control, load, balance of systems (BOS) components. Maintenance of solar lighting system, types and advantages of solar outdoor lighting.

Unit-III: Design of Photovoltaic System

Principles of designing high - Quality PV systems: load, suitability, site adequacy, weather, system balance, additional considerations. Classification of PV system - Classification - Stand-alone PV system, Grid-Interactive PV System, Small system for consumer applications, Hybrid solar PV system. Commercial solar cells - Production process of single crystalline silicon cells, multi crystalline silicon cells, amorphous silicon, cadmium telluride, copper indium gallium di selenide cells. Design of solar PV systems and cost estimation.

Unit-IV: Photovoltaic Classification and Components

Classification - Central Power Station System, Distributed PV System, Stand-alone PV system, Grid Interactive PV System, small system for consumer applications - System Components - PV arrays, inverters, batteries, charge controls, net power meters - PV Array Installation, Operation, Costs, Reliability.

Unit-V: Solar Photovoltaic System Applications

Building - integrated photovoltaic units - grid-interacting central power stations - standalone devices for distributed power supply in remote and rural areas - solar cars, aircraft, space solar power satellites -Socio-economic and environmental merits of photovoltaic systems.

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Text Books:

1. Sukhatme, S.P and Nayak, J.K, "Solar Energy", Tata McGraw Hill Private Ltd, 2010.
2. Chetansingh Solanki, "Solar Photovoltaic", PHI Learning Private Ltd., 2018.
3. Partain, L.D and Fraas, L.M., "Solar Cells and their Applications", 2nd ed., Wiley, 2010.

References:

Reference Books:

1. Dr. H. Naganagouda, "Solar Power Hand Book", 2014.
2. G.N. Tiwari, "Solar Energy, Fundamentals Design, Modelling and Application", 2015.
3. Michale Boxwell, "Solar Electricity Handbook", 2017.
4. D.P. Kothari and K.C. Signal, "Renewable Energy Sources and Emerging Technologies",

PHI Publications, 2nd Edition, 2011.

Journals:

1. https://www.sciencedirect.com/journal/solar-energy-materials-and-solar-cells
2. https://onlinelibrary.wiley.com/journal/1099159x
3. https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5503869
4. https://link.springer.com/journal/11949
5. https://www.ises.org/what-we-do/publications/solar-energy-journal

Video References:

1. https://www.youtube.com/watch?v=LOVZE9WalRE
2. https://www.youtube.com/watch?v=r5A_N29ZchE
3. https://www.youtube.com/watch?v=pH03Y5KwpjU
4. https://www.youtube.com/watch?v=r5qbf5hNYUU
5. https://www.youtube.com/watch?v=yuThr48A2cY

MOOC/SWAYAM/NPTEL Courses:

1. https://archive.nptel.ac.in/courses/115/107/115107116/
2. https://archive.nptel.ac.in/courses/117/108/117108141/
3. https://archive.nptel.ac.in/courses/115/103/115103123/

4. Course Outcomes:

After the completion of syllabus, the student should be able to:

CO. No.	Course Outcome
R19PH603.1	Apply the basic principle of direct solar energy conversion to power using PV technology of radiation, the energy balance of earth.
R19PH603.2	Acquire knowledge on performance analysis of solar photovoltaic cell and limitations of solar cell.

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R19PH603.3	Build the concept to design PV systems for various applications.
R19PH603.4	Learn the socio-economic and environmental merits of photovoltaic systems for a variety of applications.
R19PH603.5	Summarize the prospects of photovoltaic technology for sustainable power generation.

<table>
<tr><td rowspan="2">R19PH604</td><td rowspan="2">Medical Physics</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">1. Course Description:</td></tr>
<tr><td colspan="6">This course will provide a solid background in the radiation physics, interaction of radiation with matter and the basic dosimetry concepts and radiation detectors. It enables to make use of the methods and technologies employed in modern medical physics. It is concerned with the use of various imaging modalities to aid in the diagnosis of disease, radiation therapy and radiation protection.</td></tr>
<tr><td colspan="6">2. Course Objectives:</td></tr>
<tr><td colspan="6">1. To teach the different electromagnetic spectrum and radiation aspects to categorize the interaction of radiation with matter.
2. To impart knowledge on the basics of how radiological imaging is computed to experiment with various imaging Equipment.
3. To review the radiation principles and to utilize the working and applications of various advanced analytical devices.</td></tr>
<tr><td colspan="6">3. Syllabus</td></tr>
<tr><td colspan="6">Unit-I: Introduction to X-Rays</td></tr>
<tr><td colspan="6">Electromagnetic Spectrum - Production of X-rays - X-ray Spectra - Bremsstrahlung - Characteristic X-ray - X-ray Tubes - Coolidge Tube - X-ray Tube Design - Tube Cooling - Stationary Mode - Rotating Anode X-ray Tubes - Tube Rating - Quality and Intensity of X-ray, X-ray Generator Circuits - HT Cables.</td></tr>
<tr><td colspan="6">Unit-II: Radiation Physics</td></tr>
<tr><td colspan="6">Radiation Units - Exposure - Absorbed Dose - Rad Gray - Relative Biological Effectiveness - Effective Dose - Sievert - Inverse Square Law - Interaction of Radiation with Matter - Linear Attenuation Coefficient. Radiation Detectors -Thisble Chamber - Condenser Chambers - Geiger Counter - Scintillation Counter - Ionization Chamber - Dosimeters.</td></tr>
<tr><td colspan="6">Unit-III: Medical Imaging Physics</td></tr>
<tr><td colspan="6">Radiological Imaging - Radiography - Filters - Grids - Cassette - X-ray Film - Film Processing - Fluoroscopy - Computed Tomography Scanner - Principal Function - Display - Generations - Mammography. Ultrasound Imaging, Magnetic Resonance Imaging - Thyroid Uptake System - Gamma Camera (Only Principle, Function and Display)</td></tr>
<tr><td colspan="6">Unit-IV: Radiation Therapy Physics</td></tr>
</table>

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Radiotherapy - Kilo Voltage Machines - Deep Therapy Machines - Tele-cobalt Machines - Medical Linear Accelerator. Basics of Teletherapy Units - Deep X-ray, Telecobalt Units, Medical Linear Accelerator - Radiation Protection - External Beam Characteristics - Phantom - Dose Maximum and Build Up - Bolus - Percentage Depth Dose - Tissue - Air Ratio - Back Scatter Factor.
Unit-V: Radiation Protection
Principles of Radiation Protection - Protective Materials - Radiation Effects - Somatic, Genetic Stochastic and Deterministic Effect, Personal Monitoring Devices - TLD Film Badge - Pocket Dosimeter.
Text Books:
1. Thayalan, K. "Basic Radiological Physics", Jayapee Brothers Medical Publishing Pvt Ltd, New Delhi, 2003. 2. Khan, F.M. "Physics of Radiation Therapy", Williams and Wilkins [3rd Edition] 2003.
References:
Reference Books: 1. Williams and Wilkins, "Christensen's Physics of Diagnostic Radiology", Cutry Dowdey and Murry - Lippincot, 1990. 2. Bushberg, Seibeft, Leidholdt, Boone Lippincot Williams and Wilkins, "The Essential physics of Medical Imaging [2nd Edition], 2002. **Journals:** 1. https://www.sciencedirect.com/journal/physica-medica 2. https://aapm.onlinelibrary.wiley.com/journal/15269914 3. https://iopscience.iop.org/page/medical-physics-and-biophysics 4. https://journals.lww.com/jomp/pages/default.aspx 5. https://medicalphysics.imedpub.com/ **Video References:** 1. https://www.youtube.com/watch?v=7LBkmoOuMXY 2. https://www.youtube.com/watch?v=cLMVb6NvRq4 3. https://www.youtube.com/watch?v=0q9wTyGhqFs 4. https://www.youtube.com/watch?v=gEwo4mHhzS0 5. https://www.youtube.com/watch?v=NyEqt-yF7J4 **MOOC/SWAYAM/NPTEL Courses:** 1. https://archive.nptel.ac.in/courses/113/106/113106069/ 2. https://archive.nptel.ac.in/courses/108/105/108105091/ 3. https://archive.nptel.ac.in/content/storage2/courses/104103068/module1/lec1/2.html

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4. Course Outcomes:

After the completion of syllabus, students should be able to:

CO. No.	Course Outcome
R19PH604.1	Recall on the Characteristics and Production of X-rays.
R19PH604.2	Summarize Theory of Radiation and Various Radiation Chambers.
R19PH604.3	Explain Principle and the Function of Various Imaging System.
R19PH604.4	Discuss Basic Teletherapy Techniques.
R19PH604.5	Analyze Various Measures and Radiation Protection Devices.

R19CY601	Chemical Sensors and Bio Sensors	L	T	P	C
		3	0	0	3

1. Course Description:

This course provides the understanding of how to measure and analyze chemical and biological processes but also contributes to advancements in various fields that directly impact daily life and global challenges. These types of sensors are critical in scientific research and help in research development, chemical analysis and environmental studies, healthcare, pharmaceuticals, and biological research and medical diagnostics for biological contaminants or pathogens. The aim of this course is to offer students with an insight into the engineering students for optimal utilization of resources in scientific, research, technological, and industrial applications.

2. Course Objectives:

1. To obtain the knowledge about basic principles of biological, chemical and optical sensors and its characteristics applications
2. To acquire industrial and medical applications in sensors and key its role in medicinal and industrial real time benefits.
3. To study innovative methods and up-to-date chemical knowledge that inspires pupils to Communicate well and express them.
4. To gain the knowledge of sensors and its types in various industrial and research development field.

3. Syllabus

Unit-I: Introduction to Sensors

Definitions, Basic principles, theoretical background-components of interactions (covalent and non-covalent), Fundamental sensing, Molecular sensors.

Unit-II: Chemical Sensing Elements

Ionic recognition: molecular recognition-chemical recognition agent-spectroscopic recognition- biological Recognition agents; Immobilization of biological components: performance reactors of Urea Biosensors, Amino Acid Biosensors, Glucose Biosensors and Uric Acid, factors affecting the performance of sensors.

Unit-III: Biosensors

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Bio sensors: Catalytic biosensors; mono enzyme electrodes; bi-enzyme electrodes: enzyme sequence electrodes and enzyme competition electrodes; Affinity-based biosensors; Inhibition based biosensors; cell-based biosensors; Biochips and biosensor arrays; problems and limitations.
Unit-IV: Chemical Sensors
Introduction to chemical sensing; Potentiometry: fundamental principles, membrane potentials, Applications of potentiometry; ion-selective electrodes; Amperometry: fundamental principles, diffusion limited currents, Applications of Amperometry; the Clark oxygen electrode; glucose sensors in diabetes: enzyme electrodes, immunosensors.
Unit-V: Application of Sensors
Automotive Sensors: Environmental Sensors-Sensors for Medical Diagnosis and patient monitoring, Aerospace sensors.
Text Books:
1. Brain R Eggins -Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996 2. T.E. Edmonds, Chapman and Hall: Principles of Chemical Sensors, J Janata, Plenum Press
References:
Reference Books: 7. Chemical Sensors and Biosensors; Brian, R Eggins; Wiley; New York, Chichester, 2002. 8. Biosensor: A Practical Approach, J. Cooper & C. Tass, Oxford University Press, 2004. 3. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing, Co,Inc, 1993. 4. Sensors- A Comprehensive study-W.Gopal, J Hesse, J N Zemel **Journals:** 1. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118354162 2. https://www.springer.com/series/5346 3. https://pubs.rsc.org/en/content/articlelanding/2015/ra/c4ra13080d 4 https://www.sciencedirect.com/science/article/abs/pii/S0166526X03801149 **Video References:** 1. https://www.youtube.com/watch?v=8-Gtr6eWSTY 2 .https://www.youtube.com/watch?v=z4hgRj5QsZQ 3. https://www.youtube.com/watch?v=9IVmGDgVFdQ. 4. https://www.youtube.com/watch?v=kQ6CY1qpGjY 5. https://www.youtube.com/watch?v=nfxhJxmuUYE **MOOC/SWAYAM/NPTEL Courses:** 1. https://nptel.ac.in/courses/102104062 2. https://onlinecourses.nptel.ac.in/noc24_ee45/preview 3. https://nptel.ac.in/courses/115107122

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4. **Course Outcomes:**

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY601.1	To understand the basic principles of biosensing in terms of biological, chemical and optical responses.
R19CY601.2	To realize the chemical sensing methods and material characteristics to be applied in biosensors.
R19CY601.3	Demonstrate knowledge of the industrial and socioeconomic context of biosensor development and market.
R19CY601.4	Understand the operation principle of potentiometric, aerometric sensors their applications.
R19CY601.5	Apply the sensor measurements for various applications.

R19CY602	**Energy Storage Devices**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This course provides the understanding of how to measure and analyze chemical and biological processes but also contributes to advancements in various fields that directly impact daily life and global challenges. These types of sensors are critical in scientific research and help in research development, chemical analysis and environmental studies, healthcare, pharmaceuticals, and biological research and medical diagnostics for biological contaminants or pathogens. The aim of this course is to offer students with an insight into the engineering students for optimal utilization of resources in scientific, research, technological, and industrial applications.

2. Course Objectives:

1. understanding about conventional energy resources and its applications
2. Acquire industrial compressed air, bio-chemical energy storage systems and various types of applications.
3. Obtain idea about various existing batteries to the currently available batteries to Communicate well and express them.
4. To gain knowledge of fuel cells and their basic principle, comparative performance of supercapacitors which corresponds with futuristic materials

3. Syllabus

Unit-I: Energy Demands and Energy Sources

Energy Scenario: Indian and Global Perspectives: Need, consumption and demand. Non-conventional renewable energy Sources-Potential of renewable energy sources- Solar energy types. Wind energy. Wave, tidal and OTEC.

Unit-II: Energy Storage: Different Approaches

Potential energy: Pumped hydro storage, KE and Compressed gas system: Flywheel storage, compressed air energy storage, Electrical and magnetic energy storage: Capacitors, electromagnets. Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels: Hydrogen for energy storage and Solar Ponds for energy storage

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Unit-III: Batteries

Primary, Secondary batteries; the difference between primary and secondary batteries, chemistries of primary batteries such as Zinc-Carbon, Alkaline and secondary batteries such as Lead acid, Nickel Cadmium, Metal hydrides, lithium-ion, high-temperature batteries-sodium-sulphur.

Unit-IV: Fuel Cells

Fuel Cell Technology: type of fuel cells, Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, application and limits.

Unit-V: Supercapacitors

Super/ultracapacitors; Basics of Electrochemical Supercapacitors, Types and electrolyte interfaces and their capacitances, Charge-Discharge density, RuOz as a material for electrochemical capacitors, various metal Coupling with batteries and fuel cells-Applications.

Text Books:

1. C. Daniel and Jurgen O. Besenhard, Handbook of Battery Materials, Wiley-VCH Verlag, 2011

2. Battery Technology Handbook by H. A. Kiehne, Marcel Dekker, Inc. , New York, Basel

References:

Reference Books:

1. Doughty Liaw, Narayan and Srinivasan, "Batteries for Renewable Energy Storage", The i' Electrochemical Society, New Jersy,2010.
2. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.
3. Electrochemical Supercapacitors, Scientific Fundamentals and Technological Applications
By B. E. Conway, Kluwer Academic/ Plenum Publishers, New York, Boston, Dordj€ncht,
London, Moscow, 1999.

Journals:

1. https://www.sciencedirect.com/topics/engineering/energy-storage-application

2. https://www.mdpi.com/1996-1073/16/16/5930

3. https://www.sciencedirect.com/science/article/pii/S259000722300059X

4.https://www.intechopen.com/chapters/83927

Video References:

1. https://www.youtube.com/watch?v=qMlOgDzPEKU

2 .https://www.youtube.com/watch?v=f_DTiHSZqqw

3. https://www.youtube.com/watch?v=5_lDGna9MBM

4 .https://www.youtube.com/watch?v=LKw5KjOr8hw

5. https://www.youtube.com/watch?v=E-m7Psbuup0

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1. https://www.youtube.com/watch?v=yar51GJVqgg 2. https://archive.nptel.ac.in/courses/113/105/113105102/ 3. https://onlinecourses.nptel.ac.in/noc22_ch66/preview

4. **Course Outcomes:**

After the successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY602.1	Understand the characteristics of energy from various sources and need for storage
R19CY602.2	Classify various types of energy storage and various devices used for the purpose
R19CY602.3	To address the underlying concepts, methods and application of batteries
R19CY602.4	Illustrate the various types and working principle of R fuel cells
R19CY602.5	Understand the utilization of next generation super-capacitors and its applications.

R19CY603	**Chemistry in Forensic Science**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
1. Course Description:					
This course provides the understanding of how to measure and analyze chemical and biological processes but also contributes to advancements in various fields that directly impact daily life and global challenges. These types of sensors are critical in scientific research and help in research development, chemical analysis and environmental studies, healthcare, pharmaceuticals, biological research and medical diagnostics for biological contaminants or pathogens. This course aims to offer students with an insight into the engineering students for optimal utilization of resources in scientific, research, technological, and industrial applications.					
2. Course Objectives:					
1. Understanding conventional energy resources and their applications. 2. Acquire industrial compressed air, bio-chemical energy storage systems and various types of applications. 3. Obtain ideas about various existing batteries to the currently available batteries to communicate well and express them. 4. To gain knowledge of fuel cells and their basic principle, comparative performance of supercapacitors which corresponds with futuristic materials					
3. Syllabus					
Unit-I: Preamble to Forensic Science					
Forensic Science: History and development - Scope and need of forensic science in criminal justice system- Role of the Forensic Laboratory: Organization setup of Forensic Science Laboratory: Structure and function of State, Regional and Central Forensic Science Laboratories.					

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Unit-II: Forensic Tools and Techniques
Principles of Chromatography, Classification of Chromatographic Methods, Adsorption and Partition Chromatography. Thin Layer Chromatography: Basic Principle, Setup, visualization and Forensic applications.
Unit-III: Chemistry and Analysis of Drugs
Drug Chemistry, Origin, Pharmacology, Methods of preparation, Storage, Diluents and Adulterants, Sample Handling, Optimization of Experimental Conditions, Screening- and Confirmatory Methods: Colour/spot test, Microcrystalline tests, NMR, UV Spectrophotometry, IR Spectrophotometry.
Unit-IV: Explosives and Arson
Explosives: Chemistry of explosives, Characteristics of high and low explosives. Analysis of Explosive: Pre-blast and Post blast residue collection, Systematic examination of explosives and explosion residues in the laboratory using chemical and instrumental techniques and Interpretation of results. **Arson**: Arson motives, Degrees of Arson, Scheme of analysis: Extraction of samples from debris (Direct and solvent extraction methods, SPME, Distillation), Analysis (GC-MS, SEM), Interpretation of GC-MS spectra.
Unit-V: Analytical Forensic Toxicology
Samples required in Toxicological analysis - Alternative specimens: Drugs in oral fluid, Detection of drugs in sweat etc. - Alcohol Intoxication & analysis, Chemical tests for alcohol in blood and urine. Breath Alcohol Screening devices- Method of analysis of beverages in biological materials by chemical methods (Kozelka- Hine) and instrumental Methods (GC).
Text Books:
1. James, S.H and Nordby, J.J. "Forensic Science: An introduction to scientific and investigative techniques CRC Press", 2003.
References:
Reference Books: 1. Nanda B.B and Tewari R.K, "Forensic Science in India- A vision for the twenty-first century", Select Publisher, New Delhi, 2001. 2. Houck M M, "Mute witness: trace evidence analysis", Academic Press, 2001. 3. Yinon Litrin, "Modern Methods & Application in Analysis of Explosives," John Wiley Sons, England, 1993. **Journals:** 1. https://www.sciencedirect.com/journal/forensic-chemistry 2. https://www.frontiersin.org/journals/analytical-science/sections/forensic-chemistry 3. https://link.springer.com/chapter/10.1385/1-59259-946-X:91 4. https://link.springer.com/journal/11419 **Video References:** 1. https://www.youtube.com/watch?v=wl9prpOuHD8 2. https://www.youtube.com/playlist?list=PLCP8L39atqUrkDliAkEMdIMA_idd_v0AU 3. https://www.youtube.com/watch?v=TPV6T3KpAmo

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4. https://www.youtube.com/watch?v=QevbUnyEgzs
5. https://www.youtube.com/watch?v=iNW37r_snHY
MOOC/SWAYAM/NPTEL Courses:
1. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cy28/
2. https://www.youtube.com/user/nptelhrd
3. https://www.youtube.com/c/NPTELSpecialLectureSeries

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY603.1	Understand various branches of Forensic science and their functions.
R19CY603.2	Describe how different tools and assays can be used in Investigations.
R19CY603.3	Understand the composition of drugs.
R19CY603.4	Apply summarize the chemistry behind arson and explosives.
R19CY603.5	Identify and assess the value of various techniques for forensic applications.

R19CY604	Industrial and Material Chemistry	L	T	P	C
		3	0	0	3

1. Course Description:

This course delves into the intersection of chemistry with industrial processes: exploration of large-scale chemical production methods, including reactions, separation techniques, and process optimization. This topic describes the principles and environmental impact, sustainability improvement, and industrial progression. Its main focus is on material properties, synthesis methods, and applications in technology and manufacturing.

2. Course Objectives:

1. Understand the requirements of food and packaging
2. Apply the concepts relevant to petroleum products
3. Summarize the manufacturing processes of various fertilizers.
4. Understand, identify the ingredients and types of soaps and detergents.
5. Understand the controlling methods of environmental problems in metallurgical processes.

3. Syllabus

Unit-I: Food and Packaging Industry

Chemical Composition of common foodstuffs, methods of food preservation and processing by heat, chill storage, deep freezing, drying, concentration, fermentation and radiation. Packaging- Concepts & Significances. Primary packaging media - Paper boards, metals, plastics, glass, flexible materials Labels, caps and adhesives. Testing & evaluation of

packaging media. Environmental, ecological & Economic issues, recycling and waste disposal.
Unit-II: Petrochemical Industries
Crude oil - constitution and distillation - composition of different distillates -ignition point, flash point octane number - cracking - catalysts used in petroleum industries - structure, selectivity and applications, Manufacture of synthetic petrol - Fischer Tropsh process-Manufacture of petrochemicals and petrochemical polymers.
Unit-III: Fertilizers and Speciality Chemicals
Fertilizers -Raw materials, manufacture (flow chart - chemical process with equations) of ammonium nitrate, ammonium sulphate, urea, calcium ammonium nitrate, sodium nitrate, ammonium chloride, ammonium phosphate, superphosphate of lime, NPK fertilizers. Manufacture - Properties and industrial uses of solvents - DMF, DMSO and THF.
Unit-IV: Oils, Soaps and Detergents
Oils - the difference between oils and fats - manufacture of cotton seed oil and soya bean oil - manufacture of soaps - toilet and transparent soaps - Detergents - synthetic detergents - . surface active agents and their classification - manufacture of anionic, cationic and non-ionic detergents and shampoo.
Unit-V: Metallurgy
General methods of metallurgy - ores - types - methods of concentrations of ores - hydrometallurgy, pyrometallurgy, refining of metals extraction of Cr, Mfl, Pt, U and Th. Environmental problems of chemical industries -waste management. methods of control - sewage treatment and waste management.
Text Books:
1. Sharma 8.K., Industrial Chemistry, Goel Publishing House, Meerut, 2003,
References:
Reference Books: 1. Alan Cottrel, An Introduction to Metallurgy, Orient Longman, 2000. 2. James A. Kent, Riegel's Handbook of Industrial Chemistry. Springer Science & ustness Media, 2003. **Journals:** 1. https://www.sciencedirect.com/journal/materials-chemistry 2. https://asianpubs.org/index.php/ajmc 3. https://www.rsc.org/journals-books-databases/about-journals/industrial-chemistry-materials/ 4 https://www.sciencedirect.com/journal/journal-of-industrial-and-engineering-chemistry **Video References:** 1. https://www.youtube.com/playlist?list=PLLnAFJxOjzZs8uuljB_7T4otrip_evaVz 2. https://www.youtube.com/watch?v=inz_n9veiXY 3. https://www.youtube.com/user/wwwrscorg

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4. https://www.youtube.com/channel/UCBNvvmhKeuZZhWCA7Yddkig
MOOC/SWAYAM/NPTEL Courses:
1. https://archive.nptel.ac.in/courses/104/105/104105103/
2. https://nptel.ac.in/courses/104104011
3. https://nptel.ac.in/courses/104103019

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19CY604.1	Understand the requirements of food and packaging Industries.
R19CY604.2	Apply the concepts relevant to petroleum products
R19CY604.3	Summarize the manufacturing processes of various fertilizers.
R19CY604.4	Identify the ingredients and types of soaps and detergents.
R19CY604.5	Understand the controlling methods of environmental problems in metallurgical processes.

R19HS601	English for Competitive Examinations	L	T	P	C
		3	0	0	3

1. Course Description:

This open elective course is designed to equip engineering students with the essential English language skills needed to excel in competitive examinations. Emphasizing technical proficiency and general communication, the course covers key areas such as comprehension, vocabulary building, grammar, and writing skills, all tailored to the context of engineering

2. Course Objectives:

6. Develop a strong command of technical and general English vocabulary relevant to engineering disciplines.
7. Enhance reading comprehension skills through the analysis of academic texts, articles, and examination papers.
8. Improve writing skills for technical reports, essays, and application letters.
9. Strengthen listening and speaking skills through interactive discussions, presentations, and mock interviews.
10. Familiarize students with the format and types of questions commonly found in competitive exams.

3. Syllabus

Unit I: Vocabulary Enrichment

Spelling Rules: Root words, Prefix, Suffix – Synonyms & Antonyms – Practice – Punctuations – Question Mark (?), Exclamation Mark(!), Full stop (.), Comma (,), Quotation Mark (“”), Colon (:), Semi-Colon (;), Apostrophe (‘) – Commonly Misspelled Words – Practice.

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Unit II: Essential of Tenses
Tenses – Present, Past, Future Tenses Essential – Practice – Active and Passive Voice – Direct & Indirect Speech – Fill in Blans – Sentence Correction/Error Spotting – Rearrangement of Sentences – Paragraph Completion.
Unit III : Essential Parts of Speech
Noun – Traditional and Modern Nouns – Gerund, Gender, Number, Case – Practice – Pronoun – Types of Pronouns and its Essentials – Verbs – Types of Verbs and its Essentials – Adverb – Types of Adverbs and its Essentials – Adjective – Types of Adjectives and its Essentials.
Unit IV :Parts of Speech
Prepositions – Types of Prepositions and its Essentials – Conjunctions – Types of Conjunctions and its Essentials – Interjections – Types of Interjection and its Essentials – Fill in the Blanks – Conjunctions, Preposition etc – Concord; Subject Verb agreement – Degrees of Comparison – Articles – Conditional Sentences.
Unit V : Principles of Writing
Reading Comprehension – Hints Development – Paragraph Writing – Essay Writing (Expository Essays, Persuasive Essays, Narrative Essays, Descriptive Essays) – Letter Writing/ Precise Writing – Email Etiquette/ Email Writing.
Text Books:
3. APAART: Speak Well 1 (English language and communication) 4. APPART: Speak Well 2 (Soft Skills) 5. 2. S. N. Mahalakshmi, "Communicative for Engineers", V. K. Publications; Chennai, Ninth Edition, 2019.
References:
Reference Books: 4. Rizvi M.Ashraf, "Effective Technical Communication", Tata McGraw Hill Publishing Company; New Delhi, 2007. 5. Alan Mccarthy and O'dell – English Vocabulary in Use – Third Edition – Cambridge University Press 2017. 6. Dr. Saroj Hiermath – Business Communication – Nirali Prakashan. 7. Richards C. Jack, "Interchange", Fourth edition; Cambridge University Press, 2012. 8. Butterfield, Jeff, "Soft skills for Everyone", Sixth Indian Reprint, 2015. **Journals:** 1. The Journal of English Language Teaching 2. English Language Teaching Journal 3. TESOL Quarterly **Video References:** 1. www.youtube.com/watch?v=Hzj6Lbp3z0Y 2. www.youtube.com/watch?v=53V09Wuv0m0 **Web References:** 1. https://leo.stcloudstate.edu/grammar/subverag.html 2. http://www.learningdifferences.com/Main%20Page/Topics/Compound%20Word%20Lists/Compound_Word_%20Lists_complete.htm

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3. http://examples.yourdictionary.com/examples-of-active-and-passive-voice.html
4. http://www.perfectyourenglish.com/grammar/numeral-adjectives.htm
5. https://en.wikipedia.org/wiki/Commonly_misspelled_English_words
6. https://www.englisch-hilfen.de/en/grammar/if.htm
7. http://www.englishforeveryone.org/Topics/Reading-Comprehension.htm

MOOC/SWAYAM/NPTEL Courses:

1. https://archive.nptel.ac.in/courses/109/106/109106116/
2. https://onlinecourses.nptel.ac.in/noc24_hs73/preview

6. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS601.1	Remember the Vocabulary and Punctuation rules.
R19HS601.2	Understand the concept, process and importance of communication.
R19HS601.3	Apply Essentials of the different parts of speech in English.
R19HS601.4	Organize and write grammatically correct sentences.
R19HS601.5	Make them to write and appreciate different types of prose.

R19HS602	**Personality Development and Interpersonal Skills**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

1. Course Description:

This open elective course is designed for engineering students to enhance their personal and professional growth through the development of essential interpersonal skills and personality traits. In today's competitive environment, technical proficiency alone is not sufficient; effective communication, teamwork, and emotional intelligence are critical for success in the engineering field.

2. Course Objectives:

1. To understand the components of personality and how they influence personal and professional interactions.
2. To develop effective communication skills, including verbal, non-verbal, and written communication.

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3. To cultivate emotional intelligence and self-awareness for better relationship management.
4. To enhance teamwork and collaboration skills through group activities and discussions.
5. To build confidence in public speaking and presentation skills.

3. Syllabus:

Unit-I: Personality Development

Personality: Concept, Significance, Determinants, Dimensions, Personal Grooming, Personal Hygiene, Social Etiquette.

Unit-II: Aspects of Personality Development

Character building, Leadership and qualities, Teamwork, Decision, Problem-solving, Time management, Conflict & Stress Management, Work ethics.

Unit-III:Traits Required for Personality Development

Importance of self-motivation, Attitude, Factors affecting attitude, Positive attitude, Advantages, Negative attitude, Disadvantages, Ways to develop positive attitude, Difference between Personalities having Positive and Negative Attitude, Significance, Internal & external motives

Unit-IV:Essentials of Body Language

Body Language: Verbal & Non-Verbal Communication, Significance, Types and functions of Body Language, Mock Sessions, 7'Cs of Effective Communication.

Unit-V: Interpersonal Relationships

Interpersonal Relationship, Self-Analysis (Strength & Weakness), Teaming, Types of Reams, Team Roles and Behaviour (Developing positive personality), Analysis of strengths and weakness, Group Discussion, Concept, Etiquettes, Mock GD.

Text Books:

1. APAART: Speak Well 1 (English language and communication)
2. APAART: Speak Well 2 (Soft Skills)
3. S Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010.
4. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.

References:

Reference Books:

1. Rizvi M. Ashraf, "Effective Technical Communication", Tata McGraw Hill Publishing Company; New Delhi, 2007.
2. Ladousse, Gillian Porter. Roll. Play. Oxford University Press: Oxford, 2014.
3. Richards C. Jack. Person to Person (Starter). Oxford University Press: Oxford, 2006.

Journals:

1. Journal of Personality and Social Psychology
2. International Journal of Interpersonal Relationships
3. Journal of Applied Psychology

Video References:

1. www.youtube.com/watch?v=J8N6R_Lq6I4
2. www.youtube.com/watch?v=9pTg7ZmAiH4

Web References:

1. https://leo.stcloudstate.edu/grammar/subverag.html
2. http://www.learningdifferences.com/Main%20Page/Topics/Compound%20Word%20Lists/Compound_Word_%20Lists_complete.htm
3. http://examples.yourdictionary.com/examples-of-active-and-passive-voice.html
4. http://www.perfectyourenglish.com/grammar/numeral-adjectives.htm
5. https://en.wikipedia.org/wiki/Commonly_misspelled_English_words
6. https://www.englisch-hilfen.de/en/grammar/if.htm
7. http://www.englishforeveryone.org/Topics/Reading-Comprehension.htm

MOOC/SWAYAM/NPTEL Courses:

1. nptel.ac.in/courses/109/103/109103131/
2. nptel.ac.in/courses/109/104/109104149/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS602.1	Understand the concepts, process and importance of Personality Development.
R19HS602.2	Understand the essentials of Body language.
R19HS602.3	Recognize the ethical dimensions of interpersonal relation.
R19HS602.4	Understand the concept of personality and personality development and its significance.
R19HS602.5	Understand and develop various traits required for personality development.

R19HS603	**Communication Techniques for Employability**	**L**	**T**	**P**	**C**
		3	0	0	3

1. Course Description:

This open elective course equips engineering students with essential communication skills to enhance employability in competitive job markets. Recognizing that effective communication is vital in professional settings, this course focuses on developing verbal, non-verbal, and written communication techniques tailored to the engineering field.

2. Course Objectives:

1. To understand the role of communication in professional success.
2. To improve verbal and non-verbal communication skills for interviews and presentations.

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3. To develop strong written communication skills, including resume writing and email etiquette.
4. To practice effective listening and feedback techniques.
5. To enhance networking skills and professional relationship-building.

3. Syllabus:

Unit -I: Communication Skills

Methods of communication – Verbal – Non-Verbal – Principles of Effective Communication – Barriers to effective communication – Measures to overcome barriers in effective communication.

Unit -II: Self-Management Skills

Self-regulation – Self Motivation – Significance and its uses – self-awareness – Types of self-awareness – ability to work independently – Types of Meaning and importance of stress management – Stress management techniques – physical exercise, yoga, meditation – Vacations with family and friends – Taking nature Walks.

Unit -III: Information and Communication Technology Skills

Classes of operating systems – Menu, icons and taskbar on the desktop – File concept, file operations, file organization, directory structures, and file – system structures – Creating and managing files and folders Importance and need of care and maintenance of computer – Cleaning computer components – Preparing maintenance schedule – Protecting computer against viruses – Scanning and cleaning viruses and removing SPAM files, temporary – files and folders.

Unit -IV: Entrepreneurial Skills

Entrepreneurship and society – Qualities and functions of an entrepreneur – Role and importance of an entrepreneur – Entrepreneurship as a career options.

Unit-V: Employability Quotient

Resume building – The art of participating in group discussion – Acing the Personal (HR & Technical) Interview – Frequently Asked Questions - Psychometric Analysis – Mock Interview Sessions.

Text Books:

1. APAART : Speak Well 1(English language and communication).
2. Ahmad, K. (2012). Relationship between employability and graduates' skill. International Business Management,6,440-445.
3. S Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals Pearson: New Delhi,2020.
4. Hughes,Glyn and Josephine Moate. Practical English Classroom, Oxford University Press: Oxford,2014.

References:

Reference Books:

1. Rizvi M.Ashraf, "Effective Technical Communication", Tata McGraw Hill Publishing Company; New Delhi, 2007.
2. Kalam, A.P.J. A (2006).Capacity building for entrepreneurship, University News (An AIU Newsletter), 44,189-190.

Journals:

1. Journal of Communication
2. Business Communication Quarterly

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3. International Journal of Business Communication
4. Communication Education
5. Journal of Applied Communication Research
6. Journal of Workplace Learning

Video References:

1. www.youtube.com/watch?v=kaWw9FJSy6E
2. www.youtube.com/watch?v=OT1-Z9IoUO4

NPTEL/MOOC/SWAYAM Courses:

1. nptel.ac.in/courses/109/104/109104149/
2. nptel.ac.in/courses/109/105/109105136/

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS603.1	Demonstrate the knowledge and various methods of communication.
R19HS603.2	Identify the stress management techniques.
R19HS603.3	Apply basic skills for care and maintenance of the operating system.
R19HS603.4	Understand the concept of Entrepreneurial skills.
R19HS603.5	Develop and maintain a Good Resume.

R19HS604	Mass Communication	L	T	P	C
		3	0	0	3

Course Description:

This open elective course explores the fundamental concepts and practices of mass communication, tailored specifically for engineering students. In an age where technology and communication converge, understanding mass media is crucial for effective information dissemination and public engagement. Students will examine various media forms, the role of communication in society, and the skills necessary to communicate effectively within and beyond their technical fields.

Course Objectives:

1. Analyse the evolution and functions of various media channels, including print, broadcast, and digital platforms, and their impact on society and technology.
2. Learn to create engaging and informative content suitable for diverse audiences, focusing on clarity, coherence, and effective storytelling techniques.

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3. Improve verbal and written communication skills to effectively convey technical information to non-specialist audiences, facilitating better understanding and collaboration.
4. Foster critical thinking skills to assess media content, identify biases, and understand the role of media in shaping public perception and opinion.
5. Examine ethical issues in mass communication, including the responsibilities of communicators, the impact of misinformation, and the importance of responsible media practices.

Syllabus:

Unit I Communication

Elements, Functions and Dimensions – Theories of Communication (Cross Cultural Communication,
Cultural Identity Theory, Face Negotiation Theory – Accommodation Theory (CTA), - Barriers of Communication: Semantic, Physical, Environmental, Attitudinal and Cultural.

Unit II Principles of Mass Communication

Nature and Process of Human Communication – Communication Models – Nature and Process of Mass Communication – Media Systems and Theories – Ownership – Patterns of mass media – media and Social Responsibility.

Unit III Development of Media

Print: Language and Society – Early Communications Systems in India – Newspapers and Magazines in the 19th century in India – Birth of the Indian Languages Press – The Indian Press and Freedom Movement – Journalism in Indian Languages – The press in India after Independence –Social Issues –
Radio: Development of Media as a medium of Mass Communication - Emergence of AIR – Commercial broadcasting – FM: Television – Development of Television as a Medium of Mass Communication – Historical Perspective of Television in India – Satellite and Cable Television in India – Films – Early efforts – Film as a Mass Medium – Historical Developments of Indian Films – Silent era – Indian Cinema after Independence – Parallel Cinema/Commercial cinema – Documentaries –Issues and Problems of Indian Cinema – Folk Media: Traditional Media in India – Regional Diversity – Content, Form, Utility, Evaluation, Future – New Media: Development of New Media – Convergence – Internet.

Unit IV Print Media

Reporting: News – Interviewing- Interpretative Reporting – Investigative Reporting – political Reporting – Legislative Reporting – Diplomatic Reporting – Scoops and Specialized Reporting –Editing: meaning and Purpose – Proof Reading – News Desk, editorial department set-up, news flow, copy management and organization – Headlines – Magazine Editing, Layouts, Graphics.

Unit V Advertising

Evolution and Growth of Advertising - Advertising tools and practices - Mass Media Laws concerning advertising - Ad Agency Management - Activity based on advertising - Client-related issues and process - Process of Motivation and theories of motivation - Advertising research.

Text Books:

1. Bever S.H., et.al., The Sociology of Mass Media Communications, The Social Review, The University of Keele, Staffordshire, 1969.
2. David K. Berlo, The Process of communication, Holt Rhinehart and Winston, 1960.

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3. Keval J. Kumar, Mass Communication in India, Vikas Publications New Delhi, 1994.
4. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014.

References

References Books:

3. Krishna Moorthy, V.S., Modern Trends in Printing Technology
4. Clement J. Jones, Mass Media, Code of Ethics and Councils.

Journals:

1. Journalism & Mass Communication Quarterly
2. Mass Communication and Society
3. Communication Research
4. Journal of Communication
5. New Media & Society
6. Television & New Media

Video References:

1. https://www.youtube.com/shorts/K6rUorovQ2E
2. https://www.youtube.com/shorts/fIOyB36seYg
3. https://www.youtube.com/shorts/uxM2esd93iI

NPTEL/SWAYAM/MOOC Courses:

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/125
2. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/79

4. Course Outcomes:

After successful completion of the course, the student should be able to:

CO. No.	Course Outcome
R19HS604.1	Understand basic concepts of communication and its role in society
R19HS604.2	Understands the basics of journalism and its role in society.
R19HS604.3	Introduce different types of media and their characteristics, merits and demerits.
R19HS604.4	Make students understand the historical underpinnings of media theories with relevant models.
R19HS604.5	Understand the importance of advertising and the role of journalism in framing it.

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