B.E. (Mechanical Engineering)
2022 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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CONTENTS

VISION OF THE DEPARTMENT

To excel in Mechanical Engineering education by imparting industry-relevant knowledge and skills, implementing effective teaching methodologies, nurturing innovation, and contributing to societal and entrepreneurial development.

MISSION OF THE DEPARTMENT

- To achieve a dynamic and inclusive learning environment through teaching pedagogies and continuous improvement of teaching and learning process.
- To enhance the knowledge and skills of students and faculty through research, industry collaboration, and continuous learning.
- To produce competent and innovative engineers capable of meeting the evolving needs of industry, society, and entrepreneurial development.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Apply foundational knowledge and skills to effectively solve real-world problems, showcasing advanced problem-solving abilities, strong communication, and the ability to continuously upgrade expertise in response to emerging technologies

II. Innovate and implement engineering solutions through research and development to fulfill industrial and societal requirements

III. Assist in developing innovative thinking, engaging in entrepreneurial ventures or pursuing higher studies, upholding ethical practices, and contributing to a sustainable and healthy society

PROGRAMME OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

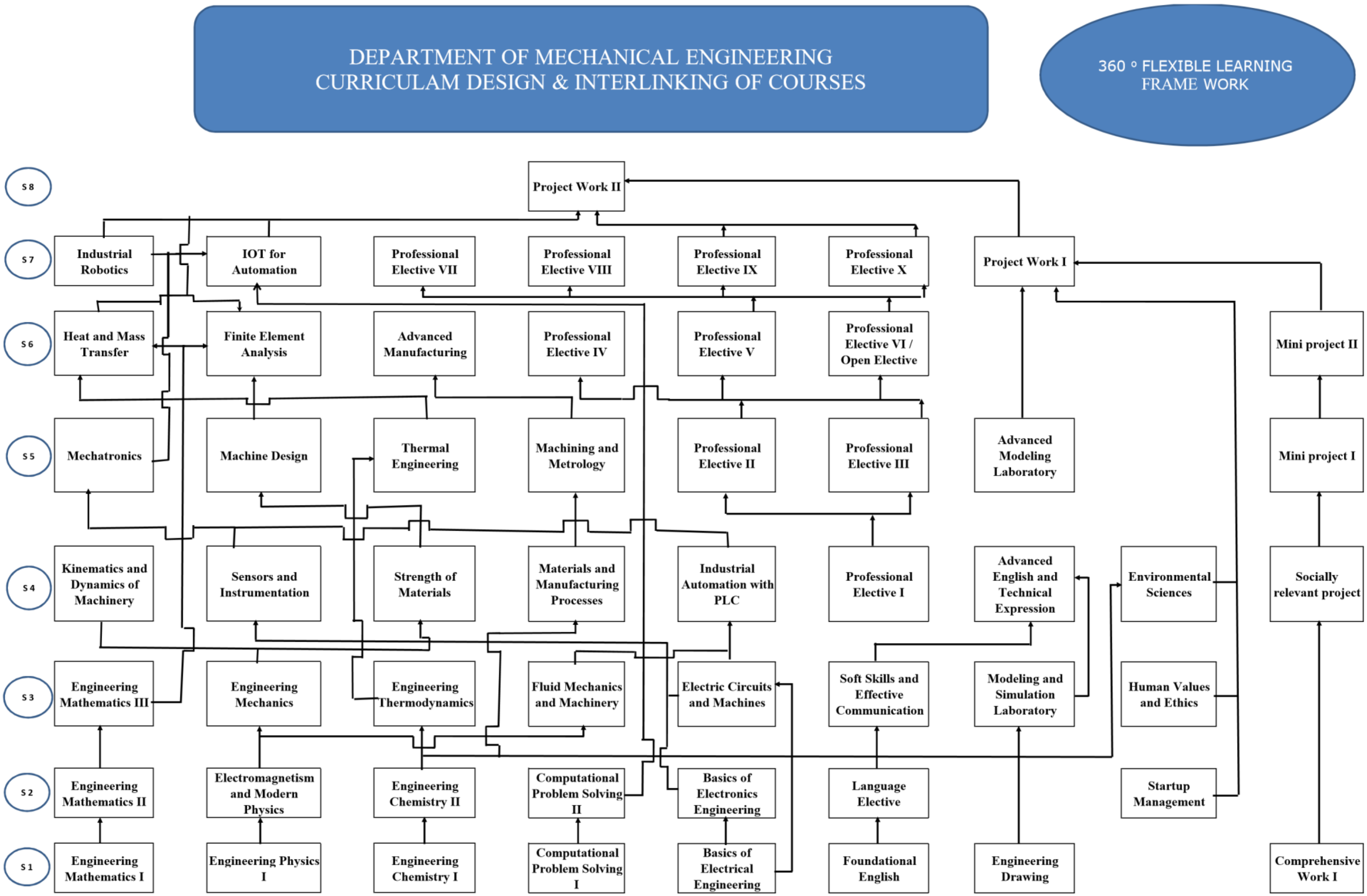
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
2. Apply knowledge acquired in mechanical engineering with an analytical / computational tools to design, analyze and provide solutions for real world applications.
3. Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

MAPPING OF PEOs WITH POs AND PSOs

PEOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
PEO I	X	X	X	X	X					X		X	X	X	X
PEO II	X	X	X	X	X	X	X		X	X	X	X	X	X	X
PEO III	X	X	X	X	X	X	X	X				X	X	X	X


DEPARTMENT OF MECHANICAL ENGINEERING
CURRICULAM DESIGN & INTERLINKING OF COURSES
360 ° FLEXIBLE LEARNING FRAME WORK
S 8
Project Work II
S 7
Industrial Robotics
IOT for Automation
Professional Elective VII
Professional Elective VIII
Professional Elective IX
Professional Elective X
Project Work I
S 6
Heat and Mass Transfer
Finite Element Analysis
Advanced Manufacturing
Professional Elective IV
Professional Elective V
Professional Elective VI / Open Elective
Mini project II
S 5
Mechatronics
Machine Design
Thermal Engineering
Machining and Metrology
Professional Elective II
Professional Elective III
Advanced Modeling Laboratory
Mini project I
S 4
Kinematics and Dynamics of Machinery
Sensors and Instrumentation
Strength of Materials
Materials and Manufacturing Processes
Industrial Automation with PLC
Professional Elective I
Advanced English and Technical Expression
Environmental Sciences
Socially relevant project
S 3
Engineering Mathematics III
Engineering Mechanics
Engineering Thermodynamics
Fluid Mechanics and Machinery
Electric Circuits and Machines
Soft Skills and Effective Communication
Modeling and Simulation Laboratory
Human Values and Ethics
S 2
Engineering Mathematics II
Electromagnetism and Modern Physics
Engineering Chemistry II
Computational Problem Solving II
Basics of Electronics Engineering
Language Elective
Startup Management
S 1
Engineering Mathematics I
Engineering Physics I
Engineering Chemistry I
Computational Problem Solving I
Basics of Electrical Engineering
Foundational English
Engineering Drawing
Comprehensive Work I

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
22PH102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
22CH103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
22GE001	FUNDAMENTALS OF COMPUTING	3	0	0	3	3	40	60	100	ES
22HS001	FOUNDATIONAL ENGLISH	1	0	2	2	3	50	50	100	HSS
22GE003	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
22GE005	ENGINEERING DRAWING	1	0	2	2	3	50	50	100	ES
22HS003	தமிழர் மரபு HERITAGE OF TAMILS#*	1	0	0	1	1	40	60	100	HSS
22ME108	COMPREHENSIVE WORK$	0	0	2	1$	2	100	0	100	EEC
Total		**15**	**1**	**10**	**21**	**26**	-	-	-	-

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22MA201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
22PH202	ELECTROMAGNETISM AND MODERN PHYSICS	2	0	2	3	4	50	50	100	BS
22CH203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
22GE002	COMPUTATIONAL PROBLEM SOLVING	3	0	0	3	3	40	60	100	ES
22GE004	BASICS OF ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
22HS002	STARTUP MANAGEMENT	1	0	2	2	3	50	50	100	EEC
	LANGUAGE ELECTIVE	1	0	2	2	3	50	50	100	HSS
22HS006	தமிழரும் தொழில்நுட்பமும் TAMILS AND TECHNOLOGY^*	1	0	0	1	1	40	60	100	HSS
22HS009	COCURRICULAR OR EXTRACURRICULAR ACTIVITY*	-	-	-	NC	-	100	-	100	HSS
Total		**15**	**1**	**10**	**21**	**26**	**-**	**-**	**-**	**-**

* Applicable for the students admitted during academic year 2024-2025. The lateral entry students have to complete these courses during III and IV semesters.

\# Students admitted during academic year 2022-2023 studied this course in semester II.

^ Students admitted during academic year 2022-2023 studied this course in semester III.

$ Applicable only for the students admitted during academic year 2022-2023.

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22ME301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	ES
22ME302	ELECTRIC MACHINES AND DRIVES	2	0	2	3	4	50	50	100	ES
22ME303	ENGINEERING THERMODYNAMICS	3	1	0	4	4	40	60	100	PC
22ME304	FLUID MECHANICS AND MACHINERY	3	0	2	4	5	50	50	100	PC
22ME305	ENGINEERING MECHANICS	3	1	0	4	4	40	60	100	PC
22HS004	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
22HS005	SOFT SKILLS AND EFFECTIVE COMMUNICATION	0	0	2	1	2	60	40	100	HSS
22ME309	MODELING AND SIMULATION LABORATORY	0	0	4	2	4	60	40	100	PC
Total		**16**	**3**	**10**	**24**	**29**	-	-	-	-

IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22ME401	KINEMATICS AND DYNAMICS OFMACHINERY	2	1	2	4	5	50	50	100	PC
22ME402	SENSORS AND TRANSDUCER	3	0	2	4	5	50	50	100	ES
22ME403	STRENGTH OF MATERIALS	2	1	2	4	5	50	50	100	PC
22ME404	INDUSTRIAL AUTOMATION WITH PLC*	2	1	2	4	5	50	50	100	PC
22ME405	MATERIALS AND MANUFACTURING PROCESSES	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
22HS007	ENVIRONMENTAL SCIENCE	2	0	0	NC	2	100	0	100	HSS
22HS008	ADVANCED ENGLISH AND TECHNICALEXPRESSION	0	0	2	1	2	60	40	100	HSS
22HS010	SOCIALLY RELEVANT PROJECT$	-	-	-	NC	-	100	-	100	HSS
Total		**16**	**3**	**12**	**23**	**31**	-	-	-	-

* LTPC for this course is 2 0 2 3 for the students admitted during academic year 2022-2023.

$ Applicable for the students admitted during academic year 2024-2025.

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22ME501	MECHATRONICS	2	0	2	3	4	50	50	100	PC
22ME502	DESIGN OF MACHINE ELEMENTS	3	1	0	4	4	40	60	100	PC
22ME503	THERMAL ENGINEERING	2	1	2	4	5	50	50	100	PC
22ME504	MACHINING AND METROLOGY	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
	OPEN ELECTIVE	3	0	0	3	3	40	60	100	PE
22ME507	MINI PROJECT I	0	0	2	1	2	60	40	100	EEC
22ME508	ADVANCED MODELING LABORATORY	0	0	4	2	4	60	40	100	EEC
Total		**16**	**2**	**12**	**24**	**30**	**-**	**-**	**-**	**-**

VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22ME601	HEAT AND MASS TRANSFER	2	1	2	4	5	50	50	100	PC
22ME602	FINITE ELEMENT ANALYSIS	2	1	2	4	5	50	50	100	PC
22ME603	COMPUTER AIDED MANUFACTURING	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
22ME607	MINI PROJECT II	0	0	2	1	2	60	40	100	EEC
Total		**15**	**2**	**8**	**21**	**25**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22ME701	INDUSTRIAL ROBOTICS	2	0	2	3	4	50	50	100	PC
22ME702	IoT FOR AUTOMATION	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
22ME707	PROJECT WORK I	0	0	4	2	4	60	40	100	EEC
Total		**16**	**0**	**8**	**20**	**24**	**-**	**-**	**-**	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22ME801	PROJECT WORK II	0	0	20	10	20	60	40	100	EEC
Total		**0**	**0**	**20**	**10**	**20**	**-**	**-**	**-**	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	50	50	100	HSS
22HSH01	HINDI	1	0	2	2	3	50	50	100	HSS
22HSG01	GERMAN	1	0	2	2	3	50	50	100	HSS
22HSJ01	JAPANESE	1	0	2	2	3	50	50	100	HSS
22HSF01	FRENCH	1	0	2	2	3	50	50	100	HSS

ELECTIVES										
PROFESIONAL ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
VERTICAL I - DESIGN ENGINEERING										
22ME001	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3	3	40	60	100	PE
22ME002	COMPOSITE MATERIALS AND MECHANICS	3	0	0	3	3	40	60	100	PE
22ME003	COMPUTER AIDED DESIGN	3	0	0	3	3	40	60	100	PE
22ME004	MECHANICAL VIBRATIONS	3	0	0	3	3	40	60	100	PE
22ME005	ENGINEERING TRIBOLOGY	3	0	0	3	3	40	60	100	PE
22ME006	FAILURE ANALYSIS AND DESIGN	3	0	0	3	3	40	60	100	PE
22ME007	DESIGN OF AUTOMOTIVE SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME008	DESIGN OF TRANSMISSION SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME009	DESIGN OF HEATING VENTILATION AND AIR CONDITIONING	3	0	0	3	3	40	60	100	PE
VERTICAL II - MANUFACTURING										
22ME010	ADVANCED CASTING AND FORMING PROCESSES	3	0	0	3	3	40	60	100	PE
22ME011	NON-TRADITIONAL MACHINING PROCESSES	3	0	0	3	3	40	60	100	PE
22ME012	WELDING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22ME013	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	3	40	60	100	PE
22ME014	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	40	60	100	PE
22ME015	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	PE

22ME016	ADDITIVE MANUFACTURING	3	0	0	3	3	40	60	100	PE
22ME017	NON DESTRUCTIVE TESTING	3	0	0	3	3	40	60	100	PE
VERTICAL III - INDUSTRIAL ENGINEERING										
22ME018	OPERATIONS MANAGEMENT	3	0	0	3	3	40	60	100	PE
22ME019	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	40	60	100	PE
22ME020	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	40	60	100	PE
22ME021	LEAN MANUFACTURING	3	0	0	3	3	40	60	100	PE
22ME022	ENGINEERING ECONOMICS	3	0	0	3	3	40	60	100	PE
22ME023	STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION	3	0	0	3	3	40	60	100	PE
22ME024	OPERATIONS RESEARCH	3	0	0	3	3	40	60	100	PE
22ME025	ENTERPRISE RESOURCE PLANNING	3	0	0	3	3	40	60	100	PE
22ME026	VALUE ANALYSIS AND VALUE ENGINEERING	3	0	0	3	3	40	60	100	PE
VERTICAL IV - THERMAL ENGINEERING										
22ME027	POWER PLANT ENGINEERING	3	0	0	3	3	40	60	100	PE
22ME028	REFRIGERATION AND AIR CONDITIONING	3	0	0	3	3	40	60	100	PE
22ME029	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
22ME030	GAS DYNAMICS AND JET PROPULSION	3	0	0	3	3	40	60	100	PE
22ME031	RENEWABLE ENERGY TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
22ME032	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	3	40	60	100	PE
22ME033	IC ENGINES AND EMISSIONS	3	0	0	3	3	40	60	100	PE
22ME034	FUEL CELL VEHICLES	3	0	0	3	3	40	60	100	PE
22ME035	INSTRUMENTATION FOR THERMAL SYSTEMS	3	0	0	3	3	40	60	100	PE
VERTICAL V - PRODUCT DESIGN AND DEVELOPMENT										
22ME036	TOOL AND DIE DESIGN	3	0	0	3	3	40	60	100	PE
22ME037	GEOMETRIC MODELLING	3	0	0	3	3	40	60	100	PE
22ME038	ERGONOMICS	3	0	0	3	3	40	60	100	PE
22ME039	PRODUCT DATA AND LIFE CYCLE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22ME040	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	40	60	100	PE

22ME041	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3	3	40	60	100	PE
22ME042	DATABASE MANAGEMENT SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME043	MECHATRONICS SYSTEM	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ROBOTICS AND AUTOMATION										
22ME044	INDUSTRIAL AUTOMATION	3	0	0	3	3	40	60	100	PE
22ME045	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
22ME046	AUTOMATION SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
22ME047	MATERIAL HANDLING SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME048	ARTIFICIAL INTELLIGENCE IN AUTOMATION	3	0	0	3	3	40	60	100	PE
22ME049	MACHINE LEARNING IN AUTOMATION	3	0	0	3	3	40	60	100	PE
22ME050	VIRTUAL INSTRUMENTATION SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME051	AUTOMATIC CONTROL SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME052	INDUSTRIAL NETWORKING	3	0	0	3	3	40	60	100	PE
VERTICAL VII - AUTOMOTIVE ENGINEERING										
22ME053	AUTOMOTIVE SYSTEM	3	0	0	3	3	40	60	100	PE
22ME054	AUTOMOTIVE ELECTRONIC SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME055	ELECTRIC AND HYBRID VEHICLE SYSTEMS	3	0	0	3	3	40	60	100	PE
22ME056	VEHICLE DYNAMICS AND CONTROL	3	0	0	3	3	40	60	100	PE
22ME057	INTELLIGENT VEHICLE SYSTEM	3	0	0	3	3	40	60	100	PE
22ME058	VEHICLE MAINTENANCE	3	0	0	3	3	40	60	100	PE

HONOURS DEGREE*										
22MEH36	TOOL AND DIE DESIGN	3	0	0	3	3	40	60	100	PE
22MEH37	GEOMETRIC MODELLING	3	0	0	3	3	40	60	100	PE
22MEH38	ERGONOMICS	3	0	0	3	3	40	60	100	PE
22MEH39	PRODUCT DATA AND LIFE CYCLE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22MEH40	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	40	60	100	PE
22MEH17	NON DESTRUCTIVE TESTING	3	0	0	3	3	40	60	100	PE

MINOR DEGREE (Other than MECHANICAL Students)*										
VERTICAL III - INDUSTRIAL ENGINEERING										
22MEM18	OPERATIONS MANAGEMENT	3	0	0	3	3	40	60	100	PE
22MEM19	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	40	60	100	PE
22MEM20	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	40	60	100	PE
22MEM21	LEAN MANUFACTURING	3	0	0	3	3	40	60	100	PE
22MEM22	ENGINEERING ECONOMICS	3	0	0	3	3	40	60	100	PE
22MEM23	STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION	3	0	0	3	3	40	60	100	PE

* Honor and Minor vertical courses offered for the students admitted during academic year 2024-2025 and 2025-2026

ONE CREDIT COURSES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22ME0XA	MODELLING AND ANALYSIS OF COMPLEX GEOMETRIES	1	0	0	1	-	100	0	100	EEC
22ME0XB	INDUSTRIAL IOT SMART TECHNOLOGY	1	0	0	1	-	100	0	100	EEC
22ME0XC	AUTONOMOUS ROBOT KINEMATICS AND CONTROL IN ROS	1	0	0	1	-	100	0	100	EEC
22ME0XD	VEHICLE MODELLING USING CARMAKER	1	0	0	1	-	100	0	100	EEC
22ME0XE	AUTOPILOT AND GUIDANCE CONTROL FOR UNMANNED VEHICLES	1	0	0	1	-	100	0	100	EEC
22ME0XF	DIGITAL ENERGY SYSTEMS	1	0	0	1	-	100	0	100	EEC

22ME0XG	ENERGY EFFICIENT BUILDINGS	1	0	0	1	-	100	0	100	EEC
22ME0XH	DESIGN CONSIDERATIONS FOR 3D PRINTING	1	0	0	1	-	100	0	100	EEC
22ME0XI	SMART MATERIALS FOR ENERGY STORAGE	1	0	0	1	-	100	0	100	EEC
22ME0XJ	CFD ANALYSIS IN ENERGY SYSTEM	1	0	0	1	-	100	0	100	EEC
22ME0XK	CONTROL SYSTEM DESIGN IN UNDERWATER VEHICLES	1	0	0	1	-	100	0	100	EEC
22ME0XL	DESIGNING AND MANUFACTURING OF MOULD AND DIE OF VARIOUS INDUSTRIAL COMPONENTS	1	0	0	1	-	100	0	100	EEC
22ME0XM	GEARBOX DESIGN AND INTRODUCTION TO PLANETARY GEARBOX	1	0	0	1	-	100	0	100	EEC

OPEN ELECTIVES

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
22OAG01	RAINWATER HARVESTING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22OCE02	COST MANAGEMENT OF ENGINEERING PROJECTS	3	0	0	3	3	40	60	100	PE
22OCB01	INTERNATIONAL BUSINESS MANAGEMENT	3	0	0	3	3	40	60	100	PE
22OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	PE
22OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	PE
22OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	PE
22OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
22OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	PE
22OIT01	DATA STRUCTURES	3	0	0	3	3	40	60	100	PE
22OIT02	C++ PROGRAMMING	3	0	0	3	3	40	60	100	PE
22OIT03	PROGRAMMING IN JAVA	3	0	0	3	3	40	60	100	PE
22OIT04	FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS	3	0	0	3	3	40	60	100	PE
22OEC01	BASICS OF ANALOG AND DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	PE
22OEC02	MICROCONTROLLER PROGRAMMING	3	0	0	3	3	40	60	100	PE
22OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	PE
22OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	PE

22OEE01	VALUE ENGINEERING	3	0	0	3	3	40	60	100	PE
22OEE02	ELECTRICAL SAFETY	3	0	0	3	3	40	60	100	PE
22OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
22OBM01	OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES	3	0	0	3	3	40	60	100	PE
22OBM02	AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT	3	0	0	3	3	40	60	100	PE
22OBM03	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	PE
22OBT01	BIOFUELS	3	0	0	3	3	40	60	100	PE
22OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	PE
22OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	PE
22OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	PE
22OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	PE
22OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	PE
22OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	PE
22OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	PE
22OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	PE
22OPH02	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	PE
22OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	PE
22OPH04	BIOPHOTONICS	3	0	0	3	3	40	60	100	PE
22OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	PE
22OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	PE
22OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	PE
22OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	PE
22OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	PE
22OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	PE
22OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	PE
22OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	PE
22OGE04	NATION BUILDING, LEADERSHIP AND SOCIAL	3	0	0	3	3	40	60	100	PE

	RESPONSIBILITY									

OPEN ELECTIVES (Not for MECHANICAL Students)										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CIA	**SEE**	**Total**	
22OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	PE
22OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	PE
22OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	PE
22OME04	SAFETY ENGINEERING	3	0	0	3	3	40	60	100	PE

SUMMARY OF CREDIT DISTRIBUTION

S.No	**CATEGORY**	**CREDITS PER SEMESTER**								**TOTAL CREDIT**	**CREDITS in %**	**Range of Total Credits**	
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**			**Min**	**Max**
1	BS	10	10							20	12.20	15%	20%
2	ES	8	6	7	4					25	15.24	15%	20%
3	HSS	3	3	3	1					10	6.10	5%	10%
4	PC			14	15	15	11	6		61	37.20	30%	40%
5	PE				3	6	9	12		30	18.29	10%	15%
6	EEC		2			3	1	2	10	18	10.97	10%	15%
Total		**21**	**21**	**24**	**23**	**24**	**21**	**20**	**10**	**164**	**100**	**-**	**-**

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CIA - Continuous Internal Assessment
SEE - Semester End Examination

22MA101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- To impart mathematical modelling to describe and explore real-world phenomena and data.
- To provide basic understanding on Linear, quadratic, power and polynomial, exponential, and multi variable models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Formulate the real-world problems as a quadratic function model.
3. Demonstrate the real-world phenomena and data into Power and Polynomial functions.
4. Apply the concept of mathematical modeling of exponential functions in Engineering.
5. Develop the identification of multivariable functions in the physical dynamical problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

MATHEMATICS MODELING OF LINEAR FUNCTIONS

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

UNIT II **9 Hours**

MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

UNIT III **9 Hours**

MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylors series, radius and interval of convergence - Tests of convergence for series of positive terms - comparison test, ratio test

UNIT IV **9 Hours**

MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decline - Exponential equations have a variable as an exponent and take the form y= abx through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

UNIT V **9 Hours**

MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS

Graphing of functions of two variables -Partial derivatives - Total derivatives - Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, Khanna, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics ,Sultan Chand & Sons2020
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018

22PH102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Implement the work-energy theorem to optimize and evaluate mechanical system performance.
2. Investigate free and forced mechanical oscillations in vibrational energy systems.
3. Compare the propagation of energy in mechanical systems through transverse and longitudinal waves.
4. Interpret the exchange of energy and work between systems using thermodynamic principles.
5. Illustrate the concept of energy and entropy to validate the mechanical properties of materials.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	-	2	-	-	1	2	-	-
2	3	2	1	2	-	-	-	-	2	-	-	1	2	-	-
3	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-
4	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-
5	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-

UNIT I **6 Hours**

CONSERVATION OF ENERGY

Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion - minimization of potential energy - equilibrium - dissipative systems – friction.

5 Hours

UNIT II

VIBRATIONAL ENERGY

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types - Damped oscillations - forced oscillations - natural frequency - resonance

UNIT III **6 Hours**

PROPAGATION OF ENERGY

Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voicere - reflection - refraction - beats

UNIT IV **7 Hours**

EXCHANGE OF ENERGY

Energy in transit - heat - Temperature - measurement - specific heat capacity and water - thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes - Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy

UNIT V **6 Hours**

ENERGY IN MATERIALS

Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

EXPERIMENT 1 **5 Hours**

Assess the physical parameters of different materials for engineering applications like radius, thickness and diameter to design the electrical wires, bridges and clothes

EXPERIMENT 2 **5 Hours**

Evaluate the elastic nature of different solid materials for modern industrial applications like shock absorbers of vehicles

EXPERIMENT 3 **5 Hours**

Analyze the photonic behavior of thin materials for advanced optoelectronic applications like adjusting a patient's head, chest and neck positions as a medical tool

EXPERIMENT 4 **5 Hours**

Investigate the phonon behavior of poor conductors for thermionic applications like polymer materials and textile materials

EXPERIMENT 5 **5 Hours**

Assess the elongation of different solid materials for industrial applications like buildings, bridges and vehicles

EXPERIMENT 6 **5 Hours**

Measure the compressibility of different liquids for modern industrial applications like navigation, medicine and imaging

Total: 60 Hours

Reference(s)

1. 1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. 2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. 3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. 4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. 5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH103 ENGINEERING CHEMISTRY I **2 0 2 3**

Course Objectives

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply nuclear transmutation reactions that lead to the formation of elements in the universe.
2. Apply atomic structure of elements in the periodic table and interpret the periodic trends in properties of elements with its anomaly.
3. Apply conditions for the formation of different chemical bonds and predict the minimum energy required for a reaction to occur.
4. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions.
5. Analyze whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **6 Hours**

ORIGIN OF ELEMENTS

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

UNIT II **6 Hours**

ATOMIC STRUCTURE AND PERIODICITY

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

UNIT III **6 Hours**

CHEMICAL BONDING

Octet rule & its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions.

UNIT IV **6 Hours**

REACTION THERMODYNAMICS

Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions

UNIT V **6 Hours**

STATES OF MATTER

Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases

EXPERIMENT 1 5 Hours

Evaluate the dissolved oxygen (DO) levels in effluent samples collected from sewage treatment plants in BIT. Ensure the suitability of outlet water for the growth of aquatic animals (fishes).

EXPERIMENT 2 5 Hours

Investigate the amount of Iron (Fe2) in a mild steel alloy sample using a spectrophotometer.

EXPERIMENT 3 4 Hours

Estimate the amount of chromium present in industry effluent samples and bottled beverages.

EXPERIMENT 4 4 Hours

Ensure the suitability of drinking water in the RO water supply in BIT based on the presence of chloride ions.

EXPERIMENT 5 4 Hours

Assess the acidic nature of effluent water from industries using the conductometric titration method.

EXPERIMENT 6 4 Hours

Measure the stain removal efficiency of the prepared soaps from stained clothes.

EXPERIMENT 7 4 Hours

Assess the purity of commercially available active pharmaceutical ingredients (aspirin) as per the government-prescribed standards.

Total: 60 Hours

Reference(s)

1. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, 2nd Edition, Oxford university press, 2020.
2. Peter Atkins, Julio D Paula and James Keeler, Atkins' Physical Chemistry, 12th Edition, Oxford university press, 2019.
3. Gareth Price, Thermodynamics of chemical processes, 2nd Edition, Oxford university press, 2019.
4. D Tabor, Gases, liquids and solids and other states of matter, 3rd Edition, Oxford University press, 2018.
5. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017.
6. J.D. Lee, Concise inorganic chemistry, 5th edition (Reprint), Blackman Science Ltd, France, Wiley-India, 2016.

22GE001 FUNDAMENTALS OF COMPUTING 3 0 0 3

Course Objectives

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply binary coding techniques to represent mechanical data, compute simple operations, and simulate results using binary codes.
2. Interpret the input–process–output flow of computation systems to diagnose communication and examine control logic
3. Demonstrate assembly language programming using the LMC model to solve computation problems involving branching, looping, and I/O.
4. Assess the effectiveness of operating system processes, including BIOS, device drivers, scheduling, and linking/loading for resource optimization
5. Develop simple software applications and web pages by integrating software development methodologies with application life cycle management to generate effective solutions for mechanical engineering product and process documentation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	-	2	2	-	-
2	3	2	-	-	2	-	-	-	-	-	-	2	2	-	-
3	3	2	2	-	2	-	-	-	-	-	-	2	2	-	-
4	2	2	2	-	3	-	-	-	-	2	-	2	2	-	2
5	2	2	3	2	3	-	-	-	-	2	-	2	2	-	2

UNIT I **8 Hours**

CODES AND COMBINATIONS

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

UNIT II **9 Hours**

COMPUTATION USING COMPUTER

Communication to computing devices through various input sources - Computational operation - its flow, functions and control - communication to output devices - Basic communication protocol.

UNIT III **11 Hours**

ASSEMBLY LANGUAGE PROGRAMMING

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input- Output - Loops - Simple programs.

UNIT IV **9 Hours**

OPERATING SYSTEM AND APPLICATION GENERATION

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.

UNIT V **8 Hours**

SOFTWARE DEVELOPMENT

Phases of application life cycle management - Software Development Methodologies - Web Page development.

Total: 45 Hours

Reference(s)

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliaz, "Little Man Computer Programming: For The Perplexed From The Ground Up", The Internet Technical Bookshop; 1st edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S.Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill International edition, Seventh edition, 2010

22HS001 FOUNDATIONAL ENGLISH 1 0 2 2

Course Objectives

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply correct grammar and business-specific vocabulary to comprehend and create written communication suitably.
2. Analyse the core meaning of non-routine business correspondence and reports on both expected and unexpected subjects.
3. Develop concise factual reports and draft non-routine business letters conveying clear information.
4. Illustrate effective questioning techniques to obtain accurate information, interpret responses, and clearly relay or document messages in the workplace.
5. Design straightforward, planned presentations on well-known business topics using basic viewpoints and limited reasoning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	3	3	-	2	2	-	-
2	2	3	-	-	-	-	-	-	3	3	-	2	2	-	-
3	2	2	3	-	-	-	-	-	3	3	-	2	2	-	-
4	3	-	-	-	-	-	-	-	3	3	-	2	2	-	-
5	2	2	2	-	-	-	-	-	3	3	-	2	2	-	-

UNIT I **15 Hours**

SELF-EXPRESSION

Self-Introduction-Recreating Interview Scenarios (with a focus on verbal communication)-Subject Verb Concord - Tenses - Common Errors in verbal communication Be-verbs Self-Introduction-Recreating interview scenarios-Haptics-Gestures-Proxemics-Facial expressions- Paralinguistic / Vocalic- Body Language- Appearance-Eye Contact-Artefacts Self-Introduction-Powerful openings and closings at the interview-Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH- questions- Prepositions-Listening to Ted talks-Listening for specific information

UNIT II **15 Hours**

CREATIVE EXPRESSION

Descriptive Expression-Picture Description and Blog Writing -Vocabulary-One-word substitution-Adjectives-Similes, Metaphors, Imagery & Idioms -Link words - Inclusive language Narrative Expression- Travelogue and Minutes of Meeting -Verbal Analogy-Sequence & Time order words - Jumbled paragraph, sentences, Sequencing-Text & Paragraph Completion-Past tense -Using quotation marks

UNIT III **15 Hours**

FORMAL EXPRESSION

Formal Letters and Emails-Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to newspapers-Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail- Conjunctional clause Punctuation-Formal Idioms-Phrases-Articles - Definite & Indefinite-Types of sentences-Modal verbs Precision in comprehension, Summary writing, Selective summary-Reading: Active reading- short paragraphs, excerpts, articles and editorials-Skimming and Scanning Reading comprehension & analysis- Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal-Note-taking-Listening: Listening for data, for specific information, for opinion-Active and passive Listening-Transcription-Paraphrasing and summarizing information-Agreeing & disagreeing-Note-taking-Writing: Summary writing, selective summary, paraphrasing, note-making, opinion pieces-Finding synonyms in the context Paraphrasing-Sentence Transformation - simple, compound, complex. Sentence Substitution-Sentence completion-Interpreting paragraphs

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010
4. Reynolds, John. Cambridge IGCSEA, First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22GE003 BASICS OF ELECTRICAL ENGINEERING 2 0 2 3

Course Objectives

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy transfer in electro mechanical conversion

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the concepts of electric charge and electron drift to demonstrate charge interaction and calculate forces between charges in mechanical and domestic electrical systems.
2. Analyze electric field patterns due to various charge distributions to differentiate their effects on conductors, planes, and spherical systems.
3. Examine magnetic field behavior for wires, solenoids, and dipoles, and relate these effects to mechanical components and induced fields.
4. Evaluate the forces on moving charges and current-carrying conductors in combined electric and magnetic fields to justify their applications in electromechanical devices.
5. Develop, simple electromechanical energy conversion systems to generate and demonstrate energy storage, induction, and switching for practical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
2	2	3	-	-	-	-	-	-	-	2	-	2	2	-	-
3	3	2	2	-	-	-	-	-	-	2	-	2	2	-	-
4	2	2	2	3	-	-	-	-	-	2	-	2	2	-	-
5	2	2	3	-	-	-	-	-	-	2	-	2	2	-	-

UNIT I **5 Hours**

ELECTRIC CHARGE

Properties of charge, additivity of charges, quantization of charge, conservation of charge , Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

UNIT II **7 Hours**

ELECTRIC FIELD

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

UNIT III **7 Hours**

MAGNETIC FIELDS

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

UNIT IV **6 Hours**

FORCE ON CHARGES

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

UNIT V **5 Hours**

ELECTRO MECHANICAL ENERGY CONVERSION

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

EXPERIMENT 1 — 6 Hours

Analysis The Behavior of A Fixed Resistor in An Electric Heater.

EXPERIMENT 2 — 9 Hours

Construct an Electrical Wiring Layout For A Basic Household Applications.

EXPERIMENT 3 — 6 Hours

Analysis The Self and Mutual Induction In A Domestic Fan.

EXPERIMENT 4 — 9 Hours

Design A Transistor-Based Electronic Switch.

Total: 60 Hours

Reference(s)

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University 2020
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill 2020
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited 2017.

22GE005 ENGINEERING DRAWING 1 0 2 2

Course Objectives

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply standard engineering drawing practices by performing lettering, numbering, dimensioning, and constructing conic sections to develop a clear understanding of fundamental drafting concepts.
2. Analyze the principles of orthographic projection to plot point projections in all four quadrants and accurately construct line projections in the first quadrant.
3. Interpret and construct projections of basic planes and solids by systematically changing their orientations with respect to principal planes.
4. Construct sectional views and surface developments of simple and truncated solids using various positions of cutting planes.
5. Illustrate the orthographic and isometric views of basic machine components to develop visualization and orthographic drawing skills.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	1	1	-	1	2	2	-	-	2	-	-
2	3	2	-	-	1	1	-	1	2	2	-	-	2	-	-
3	3	-	-	-	1	1	-	1	2	2	-	-	2	-	-
4	3	2	2	-	1	1	-	1	2	2	-	-	2	-	-
5	3	-	-	-	1	1	-	1	2	2	-	-	2	-	-

UNIT I **7 Hours**

FUNDAMENTALS OF ENGINEERING DRAWING

Definition, standards, drawing tools, drawing sheets, scales, line and its types. Practices on lettering, numbering, dimension of drawings. Construction of conic sections - ellipse, parabola and hyperbola using eccentricity method.

UNIT II **9 Hours**

PROJECTION OF POINTS AND LINES

Principles of projection, projection of points in four quadrants, first angle projection of straight lines - perpendicular to one plane, parallel and inclined to both planes.

UNIT III **9 Hours**

PROJECTION OF PLANES AND SOLIDS

Projection of simple planes and projection of simple solids - parallel, perpendicular and inclined to one plane using change of position method, inclined to both the planes

UNIT IV **9 Hours**

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

Section of Solids - simple position with cutting plane parallel, perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.

UNIT V **11 Hours**

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

Orthographic projections and isometric view of components used in engineering applications.

Total: 45 Hours

Reference(s)

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited,2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2013.

22HS003 HERITAGE OF TAMILS 1 0 0 1

Course Objectives

1. Describe the linguistic diversity in India, highlighting Dravidian languages and their features.
2. Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures.
3. Examine the role of sports and games in promoting cultural values and community bonding.
4. Discuss the education and literacy systems during the Sangam Age and their impact.
5. Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture.

Programme Outcomes (POs)

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the knowledge of Tamil language and classical literature to interpret ethical values, management principles, and social themes reflected in Sangam and modern Tamil works.
2. Assess various forms of Tamil art, sculpture, and handicrafts to identify their cultural and socio-economic significance across different eras.
3. Examine the diversity of Tamil folk arts, martial arts, and traditional games to illustrate their role in community life and heritage preservation.
4. Evaluate the Thinai concept, flora and fauna references, and the socio-economic activities of the Sangam Age to assess the cultural and literary contributions of ancient Tamils.
5. Develop presentations, reports, or creative outputs to demonstrate the contributions of Tamils to the Indian National Movement, cultural exchange, and indigenous systems like Siddha medicine.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	2	-	-	2	2	-	-	-	-	2
2	-	-	-	-	-	2	-	-	2	2	-	-	-	-	2
3	-	-	-	-	-	2	-	-	2	2	-	-	-	-	2
4	-	-	-	-	-	2	-	-	2	2	-	-	-	-	2
5	-	-	-	-	-	2	-	-	2	2	-	-	-	-	2

UNIT I **3 Hours**

LANGUAGE AND LITERATURE

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 Thirukural - 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.

UNIT II **3 Hours**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE

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.

UNIT III **3 Hours**

FOLK AND MARTIAL ARTS

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV **3 Hours**

THINAI CONCEPT OF TAMILS

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.

UNIT V **3 Hours**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE

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.

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr.S.Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

22HS003 தமிழர் மரபு **1 0 0 1**

பாடத்திட்டத்தின் நோக்கம்

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.

கற்றலின் விளைவு

1. தமிழ் மொழி மற்றும் செவ்வியல் இலக்கிய அறிவைப் பயன்படுத்தி, சங்க மற்றும் நவீன தமிழ் படைப்புகளில் பிரதிபலிக்கும் அறநெறிகள், மேலாண்மை கோட்பாடுகள் மற்றும் சமூகக் கருப்பொருள்களை விளக்குதல்.
2. பல்வேறு காலகட்டங்களில் தமிழ் கலை, சிற்பம் மற்றும் கைவினைப் பொருட்களின் கலாச்சார மற்றும் சமூக-பொருளாதார முக்கியத்துவத்தை அடையாளம் காண அவற்றை மதிப்பிடுதல்.
3. தமிழ் நாட்டுப்புறக் கலைகள், தற்காப்புக் கலைகள் மற்றும் பாரம்பரிய விளையாட்டுகளின் பன்முகத்தன்மையை ஆராய்ந்து, சமூக வாழ்க்கை மற்றும் பாரம்பரியப் பாதுகாப்பில் அவற்றின் பங்கினை விவரித்தல்.
4. திணை கருத்து, தாவரங்கள் மற்றும் விலங்குகள் பற்றிய குறிப்புகள், மற்றும் சங்க காலத்தின் சமூக-பொருளாதார நடவடிக்கைகளை மதிப்பிட்டு, பண்டைய தமிழர்களின் கலாச்சார மற்றும் இலக்கிய பங்களிப்புகளை அளவிடுதல்.
5. இந்திய தேசிய இயக்கம், கலாச்சார பரிமாற்றம் மற்றும் சித்த மருத்துவம் போன்ற பூர்வீக அமைப்புகளுக்கு தமிழர்களின் பங்களிப்பை நிரூபிக்க விளக்கக்காட்சிகள், அறிக்கைகள் அல்லது படைப்பு வெளியீடுகளை உருவாக்குதல்.

அலகு I மொழி மற்றும் இலக்கியம்: **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை: **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் 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 ofArchaeology & 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22ME108 COMPREHENSIVE WORK 0 0 20 10

Course Objectives

- Integrate knowledge from various mechanical engineering domains to tackle real-world engineering problems.
- Develop analytical skills to interpret data, apply engineering principles, and derive effective solutions.
- Enhance communication abilities through professional presentations, discussions, and technical report writing.
- Promote teamwork and professional ethics while collaboratively solving engineering challenges.
- Prepare students for career advancement by building confidence for competitive exams, interviews, and industrial problem-solving.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply the knowledge gained from various mechanical engineering courses in a comprehensive manner.
2. Analyze engineering problems using appropriate theories, principles, and data interpretation.
3. Demonstrate oral and written communication skills through presentations and technical reports.
4. Exhibit teamwork, professionalism, and ethical practices in problem-solving.
5. Prepare effectively for competitive exams, interviews, and real-world engineering challenges.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	2	-	-	-	-	2	-	2	2	2	2
2	2	3	3	2	3	2	-	-	-	2	-	2	2	2	2
3	3	1	2	1	2	1	1	1	2	2	-	2	2	2	2
4	3	1	1	1	1	2	2	2	3	2	2	2	1	1	2
5	-	-	-	-	-	1	1	1	2	2	2	3	2	2	2

22MA201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- To impart and analyze the concepts of differential equations to describe in real-world phenomena
- To provide basic understanding on differential equation models and vector field models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering.
2. Formulate the real world problems as second order linear differential equations and give solutions for the same.
3. Illustrate the real-world phenomena with magnitude and direction in the form of vector functions.
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering.
5. Apply the concepts of complex functions to analyze and solve engineering problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs and method of separation of variables- Cooling/Heating of an object - A falling object- Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model.

UNIT II **9 Hours**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS

Methods of solving second order linear ordinary differential equations -Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits.

UNIT III **9 Hours**

VECTOR DIFFERENTIAL CALCULUS

Vector and scalar functions - Fields - Derivative of vector function and geometrical interpretation- Velocity and acceleration - Gradient and its properties- Tangent and normal vectors - Directional derivative- Divergence of a vector field - Curl of a vector field - Projectile motion

UNIT IV **9 Hours**

VECTOR INTEGRAL CALCULUS

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

UNIT V **9 Hours**

COMPLEX FUNCTIONS

Basic concepts of Complex numbers Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow Electric flow - Mapping of complex functions

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B.Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

22PH202 ELECTROMAGNETISM AND MODERN PHYSICS 2 0 2 3

Course Objectives

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Investigate the mechanisms of Coulomb's law and electric potential in various charge systems.
2. Analyze the magnetic properties of materials and their effects on external magnetic fields.
3. Classify the electromagnetic waves based on their frequency and wavelength.
4. Outline the significance of the theory of relativity and explore the wave nature of particles.
5. Implement the principles of electron and hole transport to study p-type and n-type semiconductors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	1	-	-	-	-	2	-	-	1	2	-	-
2	3	2	1	2	-	-	-	-	2	-	-	1	2	-	-
3	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-
4	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-
5	3	2	2	1	-	-	-	-	2	-	-	1	2	-	-

UNIT I **6 Hours**

ELECTRICITY

Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor- Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

UNIT II **6 Hours**

MAGNETISM

Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

UNIT III **6 Hours**

ELECTROMAGNETIC WAVES AND LIGHT

Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

UNIT IV **6 Hours**

MODERN PHYSICS

Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

UNIT V **6 Hours**

ENERGY BANDS IN SOLIDS

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

EXPERIMENT 1 **5 Hours**

Analysis a I-V characteristics of a solar cell for domestic applications

EXPERIMENT 2 **5 Hours**

Determine the carrier concentration of charge carriers in semiconductors for automotive applications

EXPERIMENT 3 **5 Hours**

Investigate the photonic behavior of laser source for photo copier device

EXPERIMENT 4 **5 Hours**

Implement the principle of stimulated emission of laser for grain size distribution in sediment samples

EXPERIMENT 5 **5 Hours**

Assess the variation of refractive index of glass and water for optical communication

EXPERIMENT 6 **5 Hours**

Evaluate the band gap energy of semiconducting materials for display device applications

Total: 60 Hours

Reference(s)

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

22CH203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the electrochemical concepts to calculate the electrode potential of a metal
2. Analyze the working of batteries for the energy storage devices.
3. Analyze the specific operating conditions under which corrosion occurs and suggest a method to control corrosion
4. Analyze the role of catalyst in a chemical reaction and illustrate reaction mechanisms
5. Analyze various types of nuclear transmutation, including decay reactions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **6 Hours**

ELECTROCHEMISTRY

Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

UNIT II **6 Hours**

ENERGY STORING DEVICES

Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

UNIT III **6 Hours**

METAL CORROSION AND ITS PREVENTION

Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

UNIT IV **6 Hours**

CATALYSIS

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

UNIT V **6 Hours**

NUCLEAR REACTIONS

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - recent applications of radioactive isotopes.

EXPERIMENT 1 **4 Hours**

Measure industrial effluent water pH and assess water quality against allowed standards

EXPERIMENT 2 **4 Hours**

Iron (Fe2) in Bhavani River water: Potentiometric Analysis

EXPERIMENT 3 **4 Hours**

Construct a Zn-Cu electrochemical cell and validate the output by connecting the LED light

EXPERIMENT 4 **5 Hours**

Evaluate the corrosion percentage in concrete TMT bars

EXPERIMENT 5 **4 Hours**

Determination of the percentage of corrosion inhibition in plain-carbon steel using natural inhibitors

EXPERIMENT 6 **4 Hours**

Electroplating of copper metal on iron vessels for domestic application

EXPERIMENT 7 **5 Hours**

Determination of acid-catalyzed hydrolysis kinetics in locally sourced fruit extracts

Total: 60 Hours

Reference(s)

1. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, 2nd Edition, Wiley-VCH, 2017.
2. S. Vairam, Engineering Chemistry, 1st Edition, John Wiley & Sons, 2014.
3. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
4. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012.
5. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th Edition (revised), New Age International Publishers, 2011.
6. E. McCafferty, Introduction to Corrosion Science, 1st Edition, Springer, 2010.

22GE002 COMPUTATIONAL PROBLEM SOLVING 3 0 0 3

Course Objectives

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply visual process modeling by decomposing scenarios, logically sequencing tasks, and constructing flowcharts for problem understanding.
2. Analyze algorithmic design paradigms such as brute force, divide and conquer, greedy, and backtracking for problem-solving.
3. Evaluate appropriate data structures including linear and non-linear types using abstract data types to organize information efficiently
4. Create structured data storage and retrieval systems using local, server, and cloud database solutions including query techniques.
5. Analyze network components and services to configure and secure campus networks using addressing and firewall technologies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	2	3	-	-	-	-	-	-	-	-	2	-	-
4	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	2	3	-	-	-	-	-	-	-	-	2	-	-

UNIT I **6 Hours**

VISUAL PROCESS MODELING

Scenario decomposition - logical sequencing - drawing flowchart - preparing visual process model.

UNIT II **12 Hours**

ALGORITHMIC DESIGN THINKING

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

UNIT III **12 Hours**

DATA ORGANIZATION

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

UNIT IV **7 Hours**

DATA STORAGE

Flat File and Relational database- Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

UNIT V **8 Hours**

NETWORKING ESSENTIALS

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

Total: 45 Hours

Reference(s)

1. David D. Riley, Kennya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education,2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A.Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

22GE004 BASICS OF ELECTRONICS ENGINEERING 2 0 2 3

Course Objectives

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Assess energy transmission through mechanical, electrical, and electromagnetic means to interpret the need for signal conversion in electronics applications.
2. Apply the characteristics of PN junction diodes to demonstrate signal conditioning operations such as clipping, clamping, and multiplication in basic circuits.
3. Examine the operation of BJTs and FETs to analyze their roles in signal switching and amplification for electronic circuit applications.
4. Design and synthesize digital logic circuits using diodes and transistors to develop diode logic, RTL, DTL, and TTL configurations for practical applications.
5. Develop circuits using special devices (Zener, Varactor, LED, Solar Cell) to implement voltage regulation, energy conversion, and signal enhancement for real-world needs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	2	-	2	2	-	-
2	3	2	-	-	-	-	-	-	-	2	-	2	2	-	-
3	3	2	-	-	-	-	-	-	-	2	-	2	2	-	-
4	2	2	3	-	-	-	-	-	-	2	-	2	2	-	-
5	2	2	3	-	-	-	-	-	-	2	-	2	2	-	-

UNIT I **6 Hours**

ENERGY TRANSFER AND SIGNALS

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

UNIT II **8 Hours**

SIGNAL CONDITIONING USING DIODE

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

UNIT III **6 Hours**

SIGNAL CONDITIONING USING TRANSISTOR

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

UNIT IV **6 Hours**

LOGIC SYNTHESIS USING DIODE AND TRANSISTORS

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

UNIT V **4 Hours**

DEVICES FOR SPECIAL REQUIREMENTS

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

EXPERIMENT 1 6 Hours

Design a voltage multiplier to convert the low voltage from the mains power supply to the high voltage to operate the microwave oven.

EXPERIMENT 2 6 Hours

Design and construct regulated DC power supply for Mobile phone charger.

EXPERIMENT 3 6 Hours

Design and construct an audio amplifier circuit to play the mobile music in a huge speaker.

EXPERIMENT 4 6 Hours

Design and construct Switching circuit for the Pump to control over flow and drain condition for overhead tank using PN junction diode.

EXPERIMENT 5 **6 Hours**

Design and construct BJT based circuit to implement two way connection for stair case light application

Total: 60 Hours

Reference(s)

1. Thomas L. Floyd ,Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018)

22HS002 STARTUP MANAGEMENT 1 0 2 2

Course Objectives

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the porotypes to commercial market offering

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Implement valid and feasible startup ideas by applying design thinking, innovation, and ideation tools.
2. Develop customer personas and business model canvas by analyzing market data and buyer behavior
3. Create and refine prototypes through iterative design sprints, incorporating customer feedback.
4. Formulate marketing strategies and business plans, and design pitch decks for effective communication to investors
5. Choose appropriate commercialization strategies and implement steps to launch and legally register a startup.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	-	-	-	-	-	-	1	1	-	1	1	-
2	-	2	1	-	-	-	-	-	-	1	1	-	1	1	1
3	2	1	1	-	1	-	-	-	1	-	-	-	1	1	1
4	-	2	1	-	1	1	-	-	-	1	-	-	-	1	1
5	2	1	1	-	1	1	-	-	1	1	-	1	-	1	1

UNIT I **3 Hours**

BUSINESS MODELS AND IDEATION

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

UNIT II **3 Hours**

UNDERSTANDING CUSTOMERS

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

UNIT III **3 Hours**

DEVELOPING PROTOTYPES

Prototyping: Methods-Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

UNIT IV **3 Hours**

BUSINESS STRATEGIES AND PITCHING

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

UNIT V **3 Hours**

COMMERCIALIZATION

Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors

EXPERIMENT 1 — 1 Hours

Analysis of various business sectors

EXPERIMENT 2 — 2 Hours

Developing a Design Thinking Output Chart

EXPERIMENT 3 — 1 Hours

Creating Buyer Personas

EXPERIMENT 4 — 3 Hours

Undertake Market Study to understand market needs and assess market potential

EXPERIMENT 5 **2 Hours**
Preparation of Business Model Canvas

EXPERIMENT 6 **15 Hours**
Developing Prototypes

EXPERIMENT 7 **2 Hours**
Organizing Product Design Sprints

EXPERIMENT 8 **2 Hours**
Preparation of Business Plans

EXPERIMENT 9 **2 Hours**
Preparation of Pitch Decks

Total: 45 Hours

Reference(s)

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021

22HS006 TAMILS AND TECHNOLOGY 1 0 0 1

Course Objectives

- Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
- Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
- Examine ancient knowledge of oceans and its impact on Tamil society.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tools to design, analyze and provide solutions for fluid flow and thermal related applications.

Course Outcomes (COs)

1. Apply knowledge of ancient Tamil weaving and ceramic technologies to demonstrate their significance in material processing and utility.
2. Analyze traditional design principles and construction techniques in temples and architecture to understand cultural and engineering relevance.
3. Evaluate metallurgical and manufacturing practices of ancient Tamils to assess their technological capabilities.
4. Analyze agricultural and irrigation systems of ancient Tamil society to examine their sustainability and technological advancement.
5. Create digital content using Tamil computing tools to preserve and promote scientific Tamil in contemporary technological platforms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	-	-	-	-	-	2	-	2
2	2	2	3	-	-	2	-	-	-	-	-	-	2	-	2
3	2	2	2	-	-	2	-	-	-	-	-	-	2	-	2
4	2	3	-	-	-	2	-	-	-	-	-	-	2	-	2
5	2	2	3	-	3	2	-	-	-	-	-	-	2	-	2

UNIT I **3 Hours**

WEAVING AND CERAMIC TECHNOLOGY

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

UNIT II **3 Hours**

DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during 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.

UNIT III **3 Hours**

MANUFACTURING TECHNOLOGY

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.

UNIT IV **3 Hours**

AGRICULTURE AND IRRIGATION TECHNOLOGY

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.

UNIT V **3 Hours**

SCIENTIFIC TAMIL & TAMIL COMPUTING

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.

Total: 15 Hours

Reference(s)

1. Dr.K.K.Pillay , Social Life of Tamils , A joint publication of TNTB & ESC and RMRL
2. Dr.S.Singaravelu , Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi , The Contributions of the Tamils to Indian Culture, International
5. Institute of Tamil Studies
6. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' , Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
7. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.

8. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
9. R.Balakrishnan , Journey of Civilization Indus to Vaigai, RMRL

22HS006 - தமிழரும் தொழில்நுட்பமும் 1 0 0 1

பாடத்திட்டத்தின் நோக்கம்

- சங்க காலத்தில் வரலாறு மற்றும் கலாச்சார ஆவணங்களின் ஒரு வடிவமாக, மட்பாண்டங்கள் மீதான கிராஃபிட்டியை பகுப்பாய்வு செய்தல்.
- சிலப்பதிகாரத்தில் கட்டப்பட்ட மேடை கட்டுமானங்களின் விவரங்களையும் அவற்றின் கலாச்சார முக்கியத்துவத்தையும் பகுப்பாய்வு செய்வதன் மூலம், சங்க காலத்தில் மாவீரர் கற்களின் கட்டுமானப் பொருட்கள் மற்றும் வரலாற்று சூழலை ஆராய்தல்.
- சமுத்திரங்கள் பற்றிய பண்டைய அறிவையும், தமிழ் சமூகத்தில் அதன் தாக்கத்தையும் ஆராய்வது ஆகியவை இப்பாடத்திட்டத்தின் நோக்கம் ஆகும்.

கற்றலின் விளைவு

1. பழங்காலத் தமிழர்களின் நெசவு மற்றும் மட்பாண்டத் தொழில்நுட்ப அறிவைப் பயன்படுத்தி, அவை பொருள் பதப்படுத்துதல் மற்றும் பயன்பாட்டில் அவற்றின் முக்கியத்துவத்தை நிரூபித்தல்.
2. கோயில்கள் மற்றும் கட்டிடக்கலையில் உள்ள பாரம்பரிய வடிவமைப்பு கோட்பாடுகள் மற்றும் கட்டுமான நுட்பங்களை பகுப்பாய்வு செய்து, அவற்றின் கலாச்சார மற்றும் பொறியியல் பொருத்தத்தைப் புரிந்துகொள்ளுதல்.
3. பண்டைய தமிழர்களின் உலோகவியல் மற்றும் உற்பத்தி நடைமுறைகளை மதிப்பிட்டு, அவர்களின் தொழில்நுட்ப திறன்களை மதிப்பிடுதல்.
4. பழங்காலத் தமிழ் சமூகத்தின் வேளாண்மை மற்றும் நீர்ப்பாசன அமைப்புகளைப் பகுப்பாய்வு செய்து, அவற்றின் நிலைத்தன்மை மற்றும் தொழில்நுட்ப முன்னேற்றத்தை ஆராய்தல்.
5. தற்கால தொழில்நுட்ப தளங்களில் அறிவியல் தமிழைப் பாதுகாக்கவும், மேம்படுத்தவும் தமிழ் கணினி கருவிகளைப் பயன்படுத்தி டிஜிட்டல் உள்ளடக்கத்தை உருவாக்குதல்

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: 3

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

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: 3

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.

அலகு III <u>உற்பத்தித் தொழில் நுட்பம்</u>: 3

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.

அலகு IV <u>வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்</u>: 3

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.

அலகு V <u>அறிவியல் தமிழ் மற்றும் கணித்தமிழ்</u>: 3

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் 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 ofArchaeology & 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.

22HS009 COCURRICULAR OR EXTRACURRICULAR ACTIVITY 1 0 0 1

Course Objectives

- To develop Interpersonal and Leadership Skills
- To Foster Personal Growth and Time Management
- To enhance Community Engagement and Social Responsibility

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Develop leadership skills and teamwork capabilities by engaging in group-based organization and participation of events.
2. Build technical, creative, and interpersonal skills by actively participating in various technical events
3. Manage academic and extracurricular responsibilities through involvement in cultural, sports, and literary activities, enhancing time and organizational skills.
4. Demonstrate social responsibility by contributing to outreach and extension activities addressing community needs.
5. Apply practical knowledge and gain industrial exposure through field visits, training, and internships

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	3	3	3	-	2	-	-	2
2	-	-	-	-	-	-	-	3	3	3	-	2	-	-	2
3	-	-	-	-	-	-	-	3	3	2	-	2	-	-	2
4	-	-	-	-	-	-	-	2	2	2	-	2	-	-	2
5	2	-	-	-	-	-	-	3	3	3	-	2	-	-	2

Every student shall be required to undergo a minimum of 40 hours of Co-curricular / Extracurricular activities organized through society chapters, technical and non-technical Club activities during the II semester, failing which he/she shall not be permitted to appear for the VIII Semester examination. Such students are permitted to appear for the Semester End examinations only after completing the requirements. The attendance of the courses / events shall be maintained on the regular basis by the concerned Co-coordinators and made available in the Office of the Controller of Examinations before the commencement of Semester end examinations of Semester II.
The following co-curricular and extra-curricular activities are conducted on a regular basis and is compulsory for all students. The students' performances are assessed on the basis of their participation and organization of events in voluntary services, performance in technical and nontechnical events, games and sports, performance in literary activities, performance in cultural activities and their participation in District/Regional/State/National and International level events.

Co-Curricular activity

Technical events organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to Workshop, Seminar, Conference, Symposium Technical Contest Competition, Field visit, Industrial Training, and Internships.

Extracurricular activity

Non-Technical Events Organized through departments, Special labs, Clubs, Society and Chapters etc. includes but not limited to NSS Camp, NCC Camp, YRC activity, Yoga, Sports and games, Cultural events, Outreach activity and Extension activity.

Total: 40 Hours

22ME301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Introduce the basic concepts of partial differential equations
- Introduce the numerical techniques of interpolation in various intervals in real life situations

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications..

Course Outcomes (COs)

1. Illustrate the concepts of partial differential equations and the methods of solving them.
2. Apply numerical techniques to solve the algebraic, transcendental equations.
3. Interpret results obtained through interpolation and numerical differentiation in the context of engineering applications.
4. Apply numerical techniques to solve ordinary differential equations in engineering contexts.
5. Apply numerical techniques to solve partial differential equations arising in science and engineering problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
2	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
4	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
5	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

PARTIAL DIFFERENTIAL EQUATIONS

Formation - Solutions of standard types of first order equations - Lagranges equation - Linear partial differential equations of second and higher order with constant coefficients.

UNIT II **9 Hours**

SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

Solution of algebraic and transcendental equations - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Pivoting - Gauss Jordan method - Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen values of a matrix by Power method and Jacobis method for symmetric matrices.

UNIT III **9 Hours**

INTERPOLATION AND NUMERICAL DIFFERENTIATION

Interpolation with equidistant point - Lagrange Interpolation Polynomial - Newton Interpolating Polynomial using divided Difference Table - Numerical differentiation using interpolation.

UNIT IV **9 Hours**

INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step methods - Taylors series method - Eulers method - Modified Eulers method - Fourth order Runge - Kuta method for solving first order equations - Multi step methods - Milnes and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V **9 Hours**

NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS

Finite difference techniques for the solution of two dimensional Laplaces and Poisons equations on rectangular domain - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods - One dimensional wave equation by explicit method.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Grewal. B. S, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2015.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5th Edition, 2015.

22ME302 ELECTRIC MACHINES AND DRIVES 2 0 2 3

Course Objectives

- To understand the construction, operation and characteristics of various types of DC machines.
- To understand the operation and performance of special machines.
- To understand the construction working and performance characteristics of single phase and three phase induction motor.
- To understand the construction working and performance characteristics of single phase and three phase induction motor.
- To understand the characteristics and modes of excitation of stepper motor.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the principles of DC machines to interpret constructional features, working mechanisms, and performance characteristics of DC motors and generators.
2. Analyze various starting, braking, and speed control methods of single and three-phase induction motors using conventional and automated techniques.
3. Evaluate the static and dynamic performance of stepper and servo motors with driver circuitry for real-time control applications.
4. Analyze the operation and control of permanent magnet brushless DC motors using microcontroller-based systems.
5. Create and simulate motor drive systems using suitable power electronic converters for different types of motors.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	2	3	-	-	-	-	-	-	-	-	2	-	-
4	2	2	2	3	-	-	-	-	-	-	-	-	2	-	-
5	2	2	2	3	2	-	-	-	-	-	-	-	2	-	-

UNIT I **5 Hours**

DC MACHINES

Generator and Motor - Construction - Principle of operation - Types - Characteristics - Armature reaction and commutation - Starting and Speed control - Various Testing - Braking -Applications.

UNIT II **6 Hours**

SINGLE AND THREE PHASE INDUCTION MOTORS

Concept of Rotating Magnetic Field - Construction - Types of rotor - Need for starters - Methods of starting - Fully automated starters: DOL, Autotransformer, star delta starter - Rotor resistance starter - Methods of braking, Methods of Speed Control - V/f Control and Pole Changing Techniques.

UNIT III **6 Hours**

STEPPER AND SERVO MOTORS

Construction and Principle of operation - Variable reluctance stepper motor, Permanent magnet stepper motor, Hybrid stepper motor, Static and dynamic characteristics, Driver circuit, AC and DC Servo Construction - Microcontroller based DC and AC Servo Control - Servo motor based feedback control - Application of AC and DC Servo Motors.

UNIT IV **7 Hours**

PERMANENT MAGNET BRUSHLESS DC MOTOR

Permanent Magnet materials - Characteristics - Construction and principle of operation - Types - Difference between mechanical and electronic commutators - Microcontroller based control of PMBLDC motor in open loop.

UNIT V **6 Hours**

POWER CONVERTERS FOR ELECTRICAL DRIVES

Control of DC motor using AC and DC Converters - Single Phase and Three Phase H - Control of AC and DC motors - PWM control of BLDC motor - Power Transistor based Motor Control.

EXPERIMENT 1 — 6 Hours

Design and develop a DC Motor Controller with Multiple Features of PWM Speed Control, Direct Speed Without PWM Speed Control (with slow Initialization), Forward/Reverse, and Sudden Brake for air compressors or vacuum cleaners.

EXPERIMENT 2 — 6 Hours

Design and develop Uni-Directional Conveyor by using Oriental Motor.

EXPERIMENT 3 — 3 Hours

Develop and simulate the DC chopper used in switched mode regulator power supply.

EXPERIMENT 4 — 6 Hours

Simulate the circuit in proteus for Controlling a DC motor using PWM and monitoring its Running status

EXPERIMENT 5 — 3 Hours

Develop a circuit for Velocity open-loop control using BLDC Motor.

EXPERIMENT 6 — 3 Hours

Simulate a circuit for 3 Servo Motor (3 LED) with Arduino in Tinkercad

EXPERIMENT 7 **3 Hours**

Design and develop a DC Motor Speed/RPM Controller Circuit for CPU fans

Total: 60 Hours

Reference(s)

1. D. P. Kothari and I. J. Nagrath, Electric Machines, Tata McGraw Hill Publishing Company Ltd, 2017.
2. T.Kenjo, Stepping motors and their microprocessor controls, Oxford University press, New Delhi, 2011.
3. T.Kenjo and S.Nagamori, Permanent magnet and Brushless DC motors, Clarendon press, London, 2015.
4. P. S. Bhimbhra, Electrical Machinery, Khanna Publishers, Seventh Edition 2018.
5. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications 4th Edition, Pearson India, 2017.

22ME303 ENGINEERING THERMODYNAMICS 3 1 0 4

Course Objectives

- To study the fundamentals of thermodynamics and zeroth law.
- To provide the knowledge on first law of thermodynamics.
- To impart the knowledge on second law of thermodynamics and entropy.
- To study the thermodynamic properties of pure substances and its phase change processes.
- To learn about gas power cycles and properties of gas mixtures.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the basic concepts and the zeroth law of thermodynamics to establish thermal equilibrium in engineering systems.
2. Assess the performance of the open and closed systems by applying the first law of thermodynamics.
3. Analyze the performance of thermodynamic systems by applying the second law of thermodynamics and quantify irreversibility using entropy and availability.
4. Compare the properties and phase change behavior of pure substances by applying property relations and thermodynamic diagrams.
5. Investigate the air-standard performance of internal combustion engines and thermodynamic behavior of gas mixtures by applying thermodynamic principles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	-	2	2
2	3	-	-	-	-	-	-	-	-	-	-	2	-	2	2
3	2	3	-	-	-	-	-	-	-	-	-	2	-	2	2
4	2	3	-	-	-	-	-	-	-	-	-	2	-	2	2
5	1	2	2	3	-	2	2	-	-	-	-	2	-	2	2

UNIT I **8 Hours**

INTRODUCTION AND ZEROTH LAW OF THERMODYNAMICS

Macroscopic and Microscopic approaches, energy, heat, work. Thermodynamic system - Types, properties, functions, states, processes and cycle. Zeroth law of thermodynamics - Temperature scale, perfect gas scale.

UNIT II **8 Hours**

FIRST LAW OF THERMODYNAMICS

First law of thermodynamics, Application of first law - Closed systems and Open systems, Thermodynamic processes in closed systems, Steady state flow processes in open systems.

UNIT III **9 Hours**

SECOND LAW OF THERMODYNAMICS

Limitations of first law of thermodynamics, Second law of thermodynamics - Kelvin - Planck and Clausius statements, Reversible and irreversible processes, Carnot theorem, Carnot engine, Clausius inequality, Entropy, Availability and irreversibility. Heat Engine, heat pump and refrigerator.

UNIT IV **10 Hours**

PROPERTIES OF PURE SUBSTANCES

Thermodynamic properties of fluids. Pure substance - Phases - Phase change processes, Steam tables and Property diagrams - (P-V), (P-T), (T-V), (T-S) and (h-s) diagrams. Ideal gas equation, Van der Waals equation and compressibility chart.

UNIT V **10 Hours**

GAS MIXTURES AND GAS POWER CYCLES

Thermodynamics and properties of ideal gas mixture and perfect gas mixture - Dalton's law of partial pressure, Amagat's law. Psychrometric properties and processes - Psychrometric chart. Air standard cycles Otto, Diesel and Dual cycles - mean effective pressure and air standard efficiency.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Y. Cengel and Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2019.
2. P.K. Nag, Engineering Thermodynamics,Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2018.
3. J.P.Holman, Thermodynamics, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi,2016.
4. R.K. Rajput, Engineering Thermodynamics, Laxmi Publications Pvt.Ltd., New Delhi, 2017.
5. Gordon J. Van Wylen, Richard E. Sonntag, Fundamentals of Classical Thermodynamics, John Wiley & Sons, 1978.

22ME304 FLUID MECHANICS AND MACHINERY 3 0 2 4

Course Objectives

- To impart knowledge on the fluid properties and fluid statics principles
- To introduce the basic concept of fluid kinematics and dynamics
- To calculate the rate of flow and energy losses in flow through pipes and open channels
- To emphasize the concepts of boundary layer theory and the importance of dimensional analysis
- To impart the knowledge of pumps and turbines

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Interpret the fundamental properties of fluids and apply fluid statics principles to measure fluid pressure using appropriate methods, and evaluate buoyancy and stability using meta-centre concepts.
2. Demonstrate the principles of fluid motion using continuity, Bernoulli’s, and momentum equations, and determine the force generated by fluid jets using velocity triangle construction.
3. Apply fluid flow principles to compute major and minor losses in pipe systems, and evaluate discharge and efficiency in open channels using standard notches and section geometry.
4. Analyze flow characteristics using Buckingham’s Pi theorem and investigate the significance of Reynolds, Froude, and Mach numbers in model testing and boundary layer behavior.
5. Investigate the working principles of centrifugal pumps and hydraulic turbines using velocity triangles, and assess their performance using efficiency metrics and characteristic curves.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	2	2	-	2	-	2	-
2	2	3	-	-	2	-	-	-	2	2	-	2	-	2	-
3	3	-	-	-	2	-	-	-	2	2	-	2	-	2	-
4	2	3	-	-	2	-	2	-	2	2	-	2	-	2	-
5	2	2	2	3	2	-	2	-	2	2	-	2	-	2	-

UNIT I **9 Hours**

FLUID PROPERTIES AND FLUID STATICS

Concept of Continuum, Properties of Fluid, Classification of fluids, Types of fluid flow Streamline, Streamlines, and path line, Pascal's Law and Hydrostatic Law, Pressure and its variation in a static Fluid, Measurement of fluid pressure Manometers, Buoyancy and meta-Centre, Stability analysis and applications

UNIT II **8 Hours**

FLUID KINEMATICS AND DYNAMICS

Continuity equation, Velocity Potential and Stream function, Bernoulli's equation, and its applications, Impulse - Momentum principle, Impact of Jet, Velocity triangle

UNIT III **9 Hours**

FLOW THROUGH PIPES AND CHANNELS

Laminar and turbulent flows in circular pipes, Major and Minor losses in pipes, Darcy Weisbach equation, Hagen Poiseuille equation, Multi reservoir problems, pipe network design, Types of open Channel flows, Measurement of discharge in open channels, Notches, Most economical channel section.

UNIT IV **9 Hours**

DIMENSIONAL ANALYSIS AND MODEL TESTING

Buckingham's Pi theorem and Application of theorem in fluid flow Reynolds, Froude, and Mach number and their applications in model testing, Boundary layer thickness, Momentum integral equation, Drag and lift, Separation of the boundary layer, and Methods of preventing the boundary layer separation

UNIT V **10 Hours**

HYDRAULIC MACHINES

Centrifugal pumps, Work done, Head developed, Pump output and Efficiencies, priming - minimum starting speed, performance of multistage pumps, Cavitation, methods of prevention, Pump characteristics, Classification of hydraulic turbines, Pelton wheel, Francis turbine, Kaplan and turbines, Specific speed, Performance characteristics, Selection of turbines, Turbine efficiencies

EXPERIMENT 1 **6 Hours**

Find the coefficient of discharge by suitable device that is most accurate to measure the fuel and air distribution in the carburetor of an IC engine in a two wheeler Also, in Pasteurization and Sterilization process. Discuss the effects of the Reynolds number and friction factor in relation to the rate of flow

EXPERIMENT 2 **3 Hours**

Analyze the friction factor of various pipes in a distribution of a water supply for domestic applications

EXPERIMENT 3 **3 Hours**

Determine the coefficient of discharge by suitable device used to monitor and control the flow of water and chemicals in water treatment plants

EXPERIMENT 4 **3 Hours**

Analyze the Lift and drag force of an aerofoil design used in a windmill for power generation

EXPERIMENT 5 **3 Hours**

Conduct the performance test of a suitable turbine that is used to extract energy from waterfalls whose water drops down from a height of about 500 m to generate power in Hydropower station

EXPERIMENT 6 **6 Hours**

Conduct the test from which electricity is to be generated has its reservoir fully filled up during the rainy season and the level drops down during summer. A turbine has to be put up such that it can accommodate both cases in a hydropower station.

EXPERIMENT 7 **6 Hours**

Determine the efficiency of a pump to pump water to a very high elevation, say >300 ft, and high viscous fluid used for an irrigation and Chocolate Industry.

Total: 75 Hours

Reference(s)

1. Yunus A Cengel, and John M Cimbala, Fluid Mechanics, Third edition, McGraw Hill Education (India) Pvt Ltd, 2014
2. Dr R.K. Bansal , A textbook of Fluid Mechanics and Hydraulic Machines, Tenth Edition, LaxmiPublications, New Delhi, 2018
3. Frank M White, Fluid Mechanics, McGraw Hill Publishing Company Ltd, New Delhi, 8th Edition 2017
4. R C Hibbler, Fluid Mechanics, Pearson, First edition, 2017
5. S K Som and G Biswas, Introduction to Fluid Machines, 3rd Edition, McGraw-Hill Education 2017
6. https://nptel.ac.in/courses/112105183

22ME305 ENGINEERING MECHANICS 3 1 0 4

Course Objectives

- To make the students to apply static equilibrium of rigid bodies both in two dimensions and also in three dimensions.
- To comprehend the effect of friction on equilibrium.
- To understand the geometrical properties of surfaces and solids.
- To understand various terms involved in Projectiles.
- To apply dynamic equilibrium of particles in solving basic problems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the fundamental laws and principles of mechanics to analyze and determine the resultant and equilibrium conditions of force systems in two and three dimensions.
2. Analyze forces in basic structural elements and frictional systems using equilibrium conditions, free body diagrams, and appropriate analytical methods such as method of joints, method of sections, and virtual work.
3. Investigate geometrical properties of sections and solids by determining centroids, moments of inertia, and principal moments to assess their structural behavior under loading.
4. Apply the principles of kinematics and kinetics to determine displacement, velocity, and acceleration for particles and rigid bodies in rectilinear and curvilinear motion.
5. Analyze the dynamic behavior of particles and rigid bodies using work-energy and impulse-momentum principles to evaluate motion, impact, and energy transformations in mechanical systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	-	1	2	-	-
2	3	3	-	2	2	1	-	-	2	1	-	1	2	-	-
3	3	2	-	-	2	-	-	-	-	-	-	1	2	-	-
4	3	3	-	2	2	1	-	-	2	1	-	1	2	-	-
5	3	3	-	2	2	1	-	-	2	1	-	1	2	-	-

UNIT I **9 Hours**

INTRODUCTION TO MECHANICS AND FORCE CONCEPTS

Principles and Concepts - Laws of mechanics - system of forces - resultant of a force system – Lami's theorem - moment of a force – Varignon's theorem - resolution of a force into force and couple - force in space - equilibrium of a particle in space.

UNIT II **9 Hours**

BASIC STRUCTURAL ANALYSIS ANDFRICTION

Beams and types of beams - Simple Trusses - Method of Joints - Method of Sections. Friction resistance - classification of friction - laws of friction - angle of repose - cone of friction - free body diagram - equilibrium of a body on a rough inclined plane - non concurrent force system - ladder friction - rope friction - wedge friction - virtual work method.

UNIT III **9 Hours**

GEOMETRICAL PROPERTIES OF SECTION

Centroids - determination by integration - moment of inertia - product of inertia - principal moment of inertia of plane areas - radius of gyration - Mass moment inertia of simple solids.

UNIT IV **9 Hours**

BASICS OF DYNAMICS - KINEMATICS

Kinematics and kinetics - displacements, velocity and acceleration - equations of motion - rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration - curvilinear motion of particles - projectiles - angle of projection - range - time of flight and maximum height - kinematics of rigid bodies.

UNIT V **9 Hours**

BASICS OF DYNAMICS - KINETICS

Newton's second law of motion – D'Alembert's principle, dynamics equilibrium - work energy equation of particles - law of conservation of energy - principle of work and energy. Principles of impulse and momentum - equations of momentum - laws of conservation of momentum. Impact - time of compression, restitution, collision - co-efficient of restitution - collision of elastic bodies by direct central impact and oblique impact - collision of small body with a massive body - kinetic energy of a particle-kinetics of rigid body rotation.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Beer F.P and Johnston Jr. E.R, Vector Mechanics for Engineers (In SI Units): Statics and Dynamics, 11th Edition, Tata McGraw Hill Publishing company, New Delhi, 2017.
2. Bhavikatti S. S. and Rajashekarappa, K.G, Engineering Mechanics, New Age International (P) Limited Publishers, 2021.
3. Hibbeller, R.C and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Edition, Pearson Education 2010.
4. Irving H. Shames and Krishna MohanaRao. G., Engineering Mechanics - Statics and Dynamics, 4th Edition, Pearson Education, 2006.
5. Meriam J. L. and Kraige L. G, Engineering Mechanics- Statics - Volume 1, Dynamics Volume 2, 5th Edition, John Wiley & Sons,2006.
6. www.nptel.iitm.ac.in/video.php?subjectId=122104015

22HS004 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Assess the importance of human values and ethics in modern society using value theories and the Schwartz Survey.
2. Apply ethical principles like honesty and compassion to foster responsible behavior in personal and professional life.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Infer ethical responses to global professional and socio-cultural challenges by applying universal human values.
5. Develop a holistic view of harmony in nature by applying co-existence principles and sustainable living practices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	3	2	3	-	-	-	-	-	-	2
2	3	2	-	-	-	3	2	3	-	-	-	-	-	-	3
3	2	3	-	-	-	2	2	2	-	-	-	-	-	-	2
4	2	3	-	-	-	3	2	3	-	-	-	-	-	-	3
5	2	2	3	-	-	3	2	3	-	-	-	-	-	-	2

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics -Openness to change -Self enhancement -Conservation -Self transcendence - Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism- Integrity-Freedom-Justice-Honesty-Truthfulness-Responsibility-Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations- Understanding and living in harmony at various levels of life-Embracing self-love and wellness-Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence. Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE

Understanding the harmony in the Nature- Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s)

1. Martin, G. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin. 2011.
2. Gupta, N. L. Human Values for the 21st Century. India: Anmol Publications Pvt. Limited. 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing.2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing. 2023.
5. A Textbook on Professional Ethics and Human Values. India: New Age International (P) Limited.2007.

22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION

0 0 2 1

Course Objectives

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes (COs)

1. Apply verbal ability skills to approach placement test tasks with clarity and confidence
2. Analyze critical thinking in verbal contexts to solve aptitude test questions accurately and confidently.
3. Formulate structured written communication such as reviews, feedback, and letters of complaint, while practicing polite expressions and critical reasoning in speech.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	2	2	-	2	-	-	2
2	2	3	-	-	-	-	-	-	2	2	-	2	-	-	2
3	2	3	-	-	-	-	-	-	2	2	-	2	-	-	2

UNIT I **10 Hours**

SELF-EXPRESSION

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives - Discourse markers – Interjections - Decision making - Synthesis - Higher order thinking Group discussion/Peer discussion - Effective Communication Types of communication - Written vs Spoken - Contractions Intonation Stress Active voice - Question tags - Confidence and body language Guided writing- Outlining Main Points - Group discussion/Peer discussion - Avoiding common errors Reduction of MTI - Common errors - Barriers to communication Accent

UNIT II **10 Hours**

CREATIVE EXPRESSION

JAM, Debate, Review writing, Social media posts Synonyms - Antonyms Cloze test Phrasal verbs Spotting errors Collocation - Commonly mispronounced

UNIT III **10 Hours**

FORMAL EXPRESSION

Writing: Giving written feedback, Review writing, and Letter of complaint. Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases - Giving written feedback, Review writing, and Letter of complaint. Critical reasoning - Modal verbs - Polite ways to express negatives

Total: 30 Hours

Reference(s)

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, Mcgraw Hill Education, 2010.
5. Personality Development & Soft Skills, BarunK.Mitra, Oxford University Press, 2012
6. Business English by Ken Taylor, Orient Blackswan, 2011

22ME309 MODELING AND SIMULATION LABORATORY 0 0 4 2

Course Objectives

- To provide the knowledge and skills to model mechanical components using geometric modeling software.
- To impart the knowledge for creating and drafting the three dimensional assembly models of a few automobiles using CAD Software.
- To provide the knowledge on generating the animation of 3D assembly models using CAD software.
- To provide the knowledge on rendering the three dimensional models using CAD software.
- To expose the knowledge to prepare the product catalogue and technical documents for the given components using software.

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tools to design, analyze and provide solutions for fluid flow and thermal related applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Create CAD models of speed reducer and spark ignition components for a chemical agitator and a 150CC Pulsar bike, ensuring accurate geometric representation.
2. Assemble CAD models of speed reducer and spark ignition components with geometric and dimensional tolerances, producing detailed drafting outputs, evaluated through a drafting.
3. Analyze motion in speed reducer and spark ignition assemblies to detect clashes during operation, demonstrated through an animation and clash detection report
4. Develop rendered CAD models of speed reducer components for a chemical agitator, integrating product catalogue documentation for coal mining applications, assessed via a catalogue.
5. Simulate the operational dynamics of spark ignition components in a four-stroke gasoline engine for a 150CC Pulsar bike, evaluated through an animation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	3	-	1	-	-	-	-	-	-	1	3	1	3
2	-	-	3	-	3	-	-	-	-	1	-	1	3	-	2
3	-	3	-	3	1	-	-	-	-	-	-	1	-	3	2
4	-	-	3	-	1	-	1	-	-	3	1	1	3	-	3
5	-	1	-	3	1	-	-	-	-	-	-	1	-	3	3

EXPERIMENT 1 **10 Hours**

Create a CAD model of speed reducer components for Chemical agitator

EXPERIMENT 2 **8 Hours**

Create a CAD model assembly and individual drafting of speed reducer assembly components by considering geometric and dimensions tolerance in each component used for the Chemical agitator

EXPERIMENT 3 **8 Hours**

Animate the motion of speed reducer assembly components and identify the clash detection between the assemblies while the Chemical agitator working.

EXPERIMENT 4 **12 Hours**

Prepare the CAD model of spark ignition in a four stroke gasoline engine component used in a 150CC Pulsar bike.

EXPERIMENT 5 **8 Hours**

Create a CAD model assembly and individual drafting of spark ignition in a four stroke gasoline engine assembly component by considering geometric and dimensions tolerance in each component used in a 150CC Pulsar bike.

EXPERIMENT 6 **7 Hours**

Construct the assembly model of spark ignition in a four stroke gasoline engine assembly component and animate the motion between the components used in a 150CC Pulsar bike.

EXPERIMENT 7 **7 Hours**

Prepare the rendering model of speed reducer assembly components and prepare a product catalogue for the Coal mining process.

Total: 60 Hours

Reference(s)

1. Geometric Modelling: Theoretical and Computational Basis towards Advanced CAD Applications, Fumihiko Kimura, 2013.
2. Interpretation of geometric dimensioning and tolerancing, Daniel E.Puncochar. 3rd ed. / revised and updated by Ken Evans, 2010.
3. Autodesk Fusion 360 Black Book (V 2.0.6508), CAD/CAM/CAE Works publishers, 3rd ed. edition, 2019, 978-1988722689, 2019.

22ME401 KINEMATICS AND DYNAMICS OF MACHINERY

2 1 2 4

Course Objectives

- To acquire the knowledge on mechanism and find the velocity and acceleration.
- To understand the concept of static and dynamic force analysis in mechanical components.
- To learn the cam mechanism and gear mechanism to transmit the motion.
- To learn the principles of turning moment, centrifugal Governor and Gyroscopic effects.
- To analyze the fundamental concept of vibration in shaft.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Demonstrate the fundamental principles of mechanisms including degrees of freedom, inversions, velocity, and acceleration analysis.
2. Infer the functions and performance characteristics of flywheels, governors, and gyroscopes in mechanical systems.
3. Construct cam profiles and gear mechanisms using kinematic relationships and friction-based drive concepts
4. Analyse the static and dynamic force analysis for rotating and reciprocating systems.
5. Investigate the behavior of vibrating systems in shafts and beams to estimate critical parameters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	3	-	-	-	2	2	-	-	2	-	-
2	2	3	-	-	-	-	-	-	2	2	-	-	2	-	-
3	2	2	3	-	-	-	-	-	2	2	-	-	2	-	-
4	2	2	1	3	-	-	-	-	2	2	-	-	2	-	-
5	2	1	1	3	-	-	-	-	2	2	-	-	2	-	-

UNIT I **6 Hours**

FUNDAMENTAL ANALYSIS OF MECHANISM

Basic terminology - Degree of freedom - Inversion of Four bar and slider crank mechanism - Velocity and acceleration analysis of mechanisms.

UNIT II **6 Hours**

FLYWHEEL, GOVERNOR AND GYROSCOPE

Flywheel -Turning moment diagram, Governor - Types and characteristics of centrifugal governors, Gyroscopes - Applications in mechanical systems.

UNIT III **6 Hours**

CAM, GEAR MECHANISMS AND FRICTION DRIVES

Introduction of cam and follower mechanism - Classification-Construction of cam profile, Gear - Terminology - Law of gearing, interference and undercutting, Gear Trains - Classification - Speed calculation - Frictional drives -Clutch and belts.

UNIT IV **6 Hours**

FORCE ANALYSIS AND BALANCING

Static and Dynamic Force analysis of mechanism - Dynamics of reciprocating Engines - Balancing of rotating and reciprocating masses.

UNIT V **6 Hours**

VIBRATION

Introduction to Vibration - Natural Frequency, Vibration of shafts and beams - Whirling of shafts - Torsional vibration of shaft.

EXPERIMENT 1 **6 Hours**

Identify the Steering mechanism used in a car also identify the velocity, acceleration of the Input and output link using CAD Software

EXPERIMENT 2 **4 Hours**

Analyze the cam profile for the four stroke internal combustion engine in a motor cycle.

EXPERIMENT 3 **4 Hours**

Analyze the type of gear train utilized in the power transmission system of an automobile.

EXPERIMENT 4 **4 Hours**

Ensure the balancing of hydraulic turbine rotating components for efficient energy conversion

EXPERIMENT 5 **4 Hours**

Identify the performance of the equipment which help to maintain the stability and orientation in the ships, and submarines.

EXPERIMENT 6 **4 Hours**

Determine the critical speed of a centrifugal pump used for irrigation applications

EXPERIMENT 7 **4 Hours**

Perform the analysis of the natural frequency of the shock absorbers in motorcycles.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. John J Uichker and Joesph E Shigley, Theory of Machines and Mechanism, Oxford University Press, United States of America, 2017
2. A Ghosh and A K Mallik, Theory of Mechanisms and Machines, East-West Press (P) Ltd. New Delhi. 2018
3. S. S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2019.
4. Sadhu Singh, Theory of Machines, Prentice Hall of India, New Delhi, 2013.
5. https://nptel.ac.in/courses/112104114/9

22ME402 SENSORS AND TRANSDUCER 3 0 2 4

Course Objectives

- To understand the concepts of calibration, characteristics and response of transducers
- To impart knowledge in the construction and characteristics of various electrical transducers
- To familiarize about different transducers and sensors

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Interpret the characteristics of instruments, analyze calibration methods, error classifications, and illustrate static and dynamic performance parameters of measurement systems.
2. Explain the principles, demonstrate the working, and evaluate the applications of variable resistance transducers including potentiometers, strain gauges, thermistors, and piezoresistive sensors.
3. Apply the concepts of variable inductance transducers by examining the working of LVDT, RVDT, eddy current sensors, synchros, and resolvers in engineering measurements.
4. Illustrate the construction and operating principles of variable capacitive transducers, and differentiate among air-gap, variable-area, and permittivity-based systems with suitable examples.
5. Analyze the operation of advanced transducers such as piezoelectric, ultrasonic, magnetostrictive, fiber optic, hall effect, photoelectric, humidity, and digital sensors, and assess their applications in modern measurement systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	-	-	-	-	-	2	2	-	-	-	-	2
2	3	2	-	-	-	-	-	-	2	2	-	-	-	-	2
3	2	2	3	-	-	-	-	-	2	2	-	-	-	-	2
4	2	2	-	3	-	-	-	-	2	2	-	-	-	-	2
5	2	2	3	-	-	-	-	-	2	2	-	-	-	-	2

UNIT I **9 Hours**

CHARACTERISTICS OF INSTRUMENTS

Units and Standards - Static calibration- Classification of errors -Error analysis -Limiting error - Probable error -Static characteristics-Accuracy, Precision, Resolution, Sensitivity, Linearity, Hysteresis, Range and Span, Drift, Dead Zone- Dynamic characteristics and order of the systems - Transducers classification

UNIT II **9 Hours**

VARIABLE RESISTANCE TRANSDUCERS

Principles of operation - Construction details -Characteristics of resistance transducers -Resistance potentiometers -Strain gauges -Resistance thermometers - Thermistors- Hot wire anemometer - Piezoresistive sensor

UNIT III **9 Hours**

VARIABLE INDUCTANCE TRANSDUCERS

Induction potentiometer -Variable reluctance transducers -Linear Variable Differential Transformer- LVDT Pressure transducer- Rotary Variable Differential Transformer-Eddy current transducers, synchro's and resolvers

UNIT IV **9 Hours**

VARIABLE CAPACITIVE TRANSDUCERS

Variable air gap type - Variable area type - Variable permittivity type - Feedback type capacitance proximity pickup - Capacitor microphone

UNIT V **9 Hours**

OTHER TRANSDUCERS

Piezoelectric transducer- Ultrasonic transducer, magneto strictive transducer, fiber optic transducers, hall effect transducers, photoelectric transducers, and humidity sensor, Digital transducer.

EXPERIMENT 1 **6 Hours**

Design and construct an electronic pressure gauge with 7 segment LED display for a compressor system

EXPERIMENT 2 **6 Hours**

Design and construct a thermometer to measure the temperature in the water geyser

EXPERIMENT 3 **6 Hours**

Speedometer for two wheeler application using Hall Effect Transducer

EXPERIMENT 4 **6 Hours**

Design and construct a weighing machine for the kitchen using strain gauge and load cell.

EXPERIMENT 5 **6 Hours**

Design and construct a light intensity meter in a closed room using optical transducers

Total: 75 Hours

Reference(s)

1. A. K. Sawhney, Puneet Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, Nineteenth edition Dhanpat Rai & Co (P) Ltd, 2012.
2. H.S.Kalsi, Electronic Instrumentation, Third Edition, Tata McGraw Hill Education Private Limited, 2012.
3. D. Patranabis, Sensors and Transducers, 2nd Edition, Prentice Hall India Pvt. Ltd, 2009.
4. E.O.Doeblin, Measurement Systems: Applications and Design , 6th Edition, Tata McGraw-Hill Book Co., 2012.
5. D. V. S. Murthy,Transducers and Instrumentation, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
6. J. P. Bentley, Principles of Measurement Systems, 4th Edition, Addison Wesley Longman Ltd., UK, 2015.

22ME403 STRENGTH OF MATERIALS 2 1 2 4

Course Objectives

- To provide knowledge on structures subjected to axial and thermal loads
- To familiarize about two-dimensional stress systems and theories of failure
- To construct shear force, bending moment diagrams and evaluate the bending stress in beams under transverse loading
- To impart knowledge on finding slope, deflection of beams and buckling of columns for different boundary conditions
- To familiarize about stresses on shafts and helical springs based on theory of torsion

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Analyze the stress and strains induced in regular and composite structures subjected to axial loads and temperature difference.
2. Assess the behaviour of thin cylinders and structures subjected to three dimensional axial loads
3. Investigate the strength criteria of beams by analyzing the shear force, bending moment, and induced bending stresses under transverse loading.
4. Analyze the stiffness criteria (slope and deflection) of beams, and buckling loads of columns, under different boundary conditions.
5. Apply torsion equation in design of circular shafts and helical springs

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	-	2	1	-	-	2	2	-	1	2	-	-
2	3	-	-	-	2	1	-	-	2	2	-	1	2	-	-
3	2	2	2	3	2	1	-	-	2	2	-	1	2	-	-
4	2	3	-	-	-	1	-	-	2	2	-	1	2	-	-
5	2	2	3	-	-	1	1	-	2	2	-	1	2	-	-

UNIT I **6 Hours**

SIMPLE STRESS AND STRAIN

Mechanical properties of Materials. Stress-strain curve - Factor of safety. Strain Energy and Impact Loading. Stepped and Composite bars - Axial Stresses, Thermal Stress and Volumetric Stresses - Elastic constants and their relationship.

UNIT II **6 Hours**

COMPOUND STRESSES AND THIN CYLINDER

State of stresses at a point, 2D Stress System, Plane Stress Condition, Mohr’s circle. Thin Cylinders - Stresses, Strain, Maximum Shear stress, Changes in dimensions and volume. Theories of Failure - Significance and Graphical Representations.

UNIT III **6 Hours**

SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS

Beams - Types of supports, loads and beams, Shear force and Bending Moment in Cantilever, simply supported and overhanging beams, Point of contra flexure. Theory of Simple Bending, Section modulus, Bending stress and stress variation along the length and section of the beam.

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay's method. Theory of Columns - Slenderness ratio, End Conditions, Equivalent length, Euler and Rankine's formula.

UNIT V **6 Hours**

TORSION IN SHAFT AND HELICAL SPRING

Theory of Torsion, Stresses and Deformations in Solid and Hollow Circular Shafts, Combined bending moment and torsion of shafts, Power transmitted to shaft, Shaft in series and parallel. Close coiled helical spring - Stresses, deflection, Maximum shear stress in spring section including Wahl's Factor, Springs in series and parallel.

EXPERIMENT 1 6 Hours

Assess the hardness of material to be used as brake shoe in bicycle to give long life with minimum wear

EXPERIMENT 2 3 Hours

Select a material to be used as brake cable in a bicycle such that the material is able to withstand axial tensile load and identify the mode of failure

EXPERIMENT 3 **3 Hours**

Assess the suitability of material as bicycle handle to withstand bending load using deflection beam apparatus

EXPERIMENT 4 **3 Hours**

Select a material to be used as bicycle fork such that the material is able to withstand axial compressive loading and identify the mode of failure

EXPERIMENT 5 **3 Hours**

Assess the suitability of material for fabricating LPG gas cylinders to withstand internal gas pressure using thin cylinder test setup

EXPERIMENT 6 **6 Hours**

Assess the suitability of material as nail for wooden furniture fabrication withstanding impact load of hammer

EXPERIMENT 7 **3 Hours**

Assess the suitability of material as a) compression spring for bicycle seat and b) tensile spring for bicycle stand to withstand axial load

EXPERIMENT 8 **3 Hours**

Select a material to be used as bicycle wheel shaft such that it is able to withstand torsion load

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, Third Edition, 2017
2. F. P. Beer and R. Johnston, McGraw Hill Education India Private Limited, Seventh edition, 2017
3. S. S. Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, Fourth edition, 2013
4. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt Ltd, New Delhi, 2015
5. William Nash and Nilanjan Malik, Strength of Materials (Schaum"s Outline Series), McGraw Hill Education, Fourth Edition, 2017
6. https://onlinecourses.nptel.ac.in/noc18_ce17/preview

22ME404 INDUSTRIAL AUTOMATION WITH PLC 2 1 2 4

Course Objectives

- To learn about industrial automation and its principles.
- To study about various types of pneumatic components and servo system.
- To impart knowledge on fluid power circuit design.
- To learn about the basics of PLC and its need for industrial automation.
- To learn the PLC programming for industrial automation.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply industrial automation principles and strategies to improve production systems.
2. Analyze and select suitable pneumatic and hydraulic components for automation system design.
3. Design fluid power circuits for speed control, sequencing, and safe operation in automation.
4. Demonstrate the architecture, components, and functionalities of PLCs for controlling automated systems.
5. Develop PLC programs using ladder logic for various industrial automation applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	1	-	-	-	2	2	-	-	2	-	1
2	2	3	-	-	3	-	-	-	2	2	-	-	2	-	2
3	2	2	3	-	3	-	-	-	2	2	-	-	2	-	3
4	3	-	-	-	2	-	-	-	2	2	-	-	2	-	1
5	2	2	3	-	3	-	-	-	2	2	-	-	2	-	1

UNIT I **6 Hours**

INDUSTRIAL AUTOMATION

Introduction to automation in production system, Types of production system, Principles and strategies of automation, Basic elements of an automated system, Advanced automation functions, Levels of automations, Automated flow lines with storage buffers, Automation for material handling, Conveyor systems, Automated guided vehicle (AGV) systems and Rail guided vehicle (RGV), Automated storage/retrieval systems, Industry 4.0.

UNIT II **6 Hours**

FLUID POWER COMPONENTS AND SERVO SYSTEMS

Sources of hydraulic power, Pump classification and its performance, Control valves, Actuators. Sources of pneumatic power, FRL unit, Control valves, Actuators. Servo systems - Hydro mechanical servo systems, Electro hydraulic servo systems and Proportional valves.

UNIT III **6 Hours**

PNEUMATIC CIRCUITS

Fluid Power Circuit Design - Speed control circuits, Synchronizing circuit, Sequencing circuit, Regenerative circuit, Fail safe circuit, Hydro pneumatic circuit, Sequential circuit design for simple applications using cascade method, Fluid power circuits - Failure and trouble shooting.

UNIT IV **6 Hours**

PROGRAMMABLE LOGIC CONTROLLER

Architecture of PLC, CPU IO modules power supply and communications, Input and output devices, Need of PLC for industrial automation, Types of PLC models, Communications - Types, Uses, Protocols, Architecture flow.

UNIT V **6 Hours**

PLC PROGRAMMING

Types of programming languages, Ladder logic diagram, Examine On/OFF, Timer, Counter, Input - Output Addressing, Data manipulation and other higher level programming instruction with case studies.

EXPERIMENT 1 **3 Hours**

Develop logic gates using PLC for conveyor Belt Sorting System.

EXPERIMENT 2 **3 Hours**

Develop a parking lot management system using timer and counter in PLC.

EXPERIMENT 3 **4 Hours**

Design and development of PLC based electro pneumatic control for double acting cylinder in automated material pushing system.

EXPERIMENT 4 **4 Hours**

Design and development of level control in Bottling station.

EXPERIMENT 5 **4 Hours**

Develop the water tank level control system using ladder logic for household applications.

EXPERIMENT 6 **4 Hours**

Develop a fire detection and alarm system using PLC for commercial applications.

EXPERIMENT 7 **4 Hours**

Develop an automatic bottle-filling system using PLC for industrial applications.

EXPERIMENT 8 **4 Hours**

Develop the ladder logic for the traffic control system.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. Mikell P Groover, Automation Production Systems and Computer Integrated Manufacturing, Pearson Education, New Delhi, 2015.
2. Anthony Esposito, Fluid Power with Applications, Pearson Education, New Delhi, 2011.
3. Frank D. Petruzella, Programmable Logic Controllers, 5th Edition, McGraw- Hill, New York, 2016.
4. Krishna Kant, Computer Based Industrial Control, 2nd Edition, Prentice Hall, New Delhi, 2011.
5. John W. Webb, Ronald A. Reis, Programmable Logic Controllers: Principles and Applications, 5th Edition, Prentice Hall Inc., New Jersey, 2003.
6. Smith Carlos, Corripio, Principles and Practice of Automatic Process Control, 3rd Edition, John Wiley & Sons, 2006.

22ME405 MATERIALS AND MANUFACTURING PROCESSES 2 0 2 3

Course Objectives

- To study the crystal structure and heat treatment process of metals
- To study the properties and applications of various metals and alloys used in engineering industries.
- To study the properties and applications of metals and manufacturing process
- To study the properties and applications of polymers and manufacturing process
- To study the properties and applications of ceramics and manufacturing process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the concepts of phase diagrams and heat treatment processes to analyze and modify the microstructure and mechanical properties of steel for engineering applications
2. Classify and evaluate engineering metals and alloys, including ferrous and non-ferrous materials, based on their microstructure, properties, and industrial applications.
3. Demonstrate metal manufacturing techniques including casting, welding, forging, and forming, and apply these processes to fabricate components for engineering applications.
4. Implement polymer manufacturing processes, and fabricate polymer products using techniques like injection moulding, compression moulding and blow moulding for practical applications.
5. Asses the properties and manufacturing methods of ceramics and apply knowledge to select appropriate processes for engineering ceramic components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	2	2	-	1	2	-	-
2	2	2	2	3	-	-	-	-	2	2	-	1	2	-	-
3	3	2	2	-	-	-	-	-	2	2	-	1	2	-	-
4	3	2	2	-	-	-	-	-	2	2	-	1	2	-	-
5	3	2	3	-	-	-	-	-	-	-	-	1	2	-	-

UNIT I **5 Hours**

PHASE DIAGRAMS AND HEAT TREATMENT

Solids solutions and alloys, Gibbs phase rule, Crystal structure, Unary and binary eutectic phase diagram, Isomorphous diagram- Iron - Carbon phase diagram. Heat Treatment - Annealing, Normalizing, Hardening and Tempering, Isothermal transformation diagrams.

UNIT II **5 Hours**

ENGINEERING METALS AND ALLOYS

Engineering materials - Classification of steel and cast-iron microstructure, Alloy steels - Effect of alloying elements on steel, Types-Stainless steel, High strength low alloy (HSLA) steel, Maraging, Tool steels. Nonferrous metals- Aluminium, copper, Magnesium and Titanium alloys, Properties and applications

UNIT III **8 Hours**

METAL MANUFACTURING PROCESSES

Casting-Classification, sand casting process, special casting process - Die casting, centrifugal casting and investment casting. Welding process ad its classifications - Arc welding-SMAW, GMAW, GTAW, FCAW. Resistance welding-Spot, butt and seam. Forging process - Open and close dies forging, Extrusion, Drawing - Principles operation and types. Special forming process - Hydro forming, Rubber pad forming, Explosive forming

UNIT IV **7 Hours**

POLYMER MANUFACTURING PROCESS

Polymers - Classifications of polymers, Thermo plastic Properties and applications (Polyethylene, Poly propylene, Polystyrene, Poly vinyl chloride, Acrylic, Nylon and Teflon). Thermo set Properties and applications (Polyester, Epoxy, Phenolic, Urea and Phenol formaldehydes). Manufacturing process - Injection moulding, Compression moulding, Blow Moulding, Extrusion - Principle, operations and applications.

UNIT V **5 Hours**

CERAMIC MANUFACTURING PROCESS

Ceramics - Classifications, Traditional ceramics, Engineering ceramics - Properties and applications of Al_2O_3, SiO_2, SiC, Si_3N_4, TiO_2, ZrO_2. Processing of ceramics- Sintering, Hot and Cold isostatic pressing, chemical vapour deposition, Slip casting-Principle, operations and applications.

EXPERIMENT 1 3 Hours

Prepare the steel samples for a hardenability test to find the hardness of the steel material for the cutting tool application.

EXPERIMENT 2 6 Hours

Prepare the steel samples for microstructural observation to classify the steel for household application.

EXPERIMENT 3 3 Hours

Develop a mould for casting to make aluminium parts.

EXPERIMENT 4 6 Hours

Fabrication of steel using MMAW, TIG and MIG welding for structural application.

EXPERIMENT 5 **3 Hours**

Make a sheet metal Box L Bracket and U channel using shearing and bending operations for the AC ventilation system.

EXPERIMENT 6 **3 Hours**

Make a cup-shaped product for beverage application

EXPERIMENT 7 **3 Hours**

Make a food plate component using injection moulding.

EXPERIMENT 8 **3 Hours**

Make a Pet bottle using Blow Moulding

Total: 60 Hours

Reference(s)

1. William D Callister Jr., Materials Science and Engineering: An Introduction, 7th Edition, John Wiley & Sons Inc., New York, 2007.
2. Avner, S.H., Introduction to Physical Metallurgy, McGraw Hill Book Company,1994.
3. P.N. Rao, Manufacturing Technology vol. I, Tata McGraw-Hill Publishing Company Private Limited, New Delhi, 2010
4. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Education Limited, New Delhi, 2013.
5. J.P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2013.
6. https://onlinelibrary.wiley.com/

22HS007 ENVIRONMENTAL SCIENCE 2 0 0 NC

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply principles of natural resource management to analyze exploitation cases in forestry, water, minerals, and agricultural sectors, assessing their environmental impacts.
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation.
3. Analyze the existing environmental challenges related to pollution and its management.
4. Analyze the impacts of unsustainable practices, waste management, climate change, and water conservation on environmental sustainability.
5. Analyze the impact of population and human activities on environment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	-	-	-	-	1	-	-	-	-	-	-	-	2
4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution: (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods - earthquake

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development: Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering, 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014

22HS008 ADVANCED ENGLISH AND TECHNICAL EXPRESSION 0 0 2 1

Course Objectives

- To enable students to achieve proficiency in academic writing
- Effectively use the language to persuade others
- Appreciate the nuances of the language and engage an audience
- Use advanced tools of language to improve communicative competence
- Prepare for professional demands at the workplace
- Give concrete expression to the plans and goals

Programme Outcomes (POs)

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply listening, reading, speaking, and writing skills in Business English to function effectively at the level of independent users.
2. Design strategies and study plans to develop the necessary skills to improve communicative competence and prepare for professional demands at the work place.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	2	2	-	2	-	-	2
2	2	-	3	-	-	-	-	-	2	2	-	2	-	-	2

UNIT – 1 - CREATIVE EXPRESSION 15 Hours

Proposals & Grant applications, Argumentative essays & editorials, Sales Pitches, Campaigning, Commercials/advertisements, effectively answering the famous interview question: 'Why should we hire you?' Sentence and paragraph formation - Rhetorical questions - Emphasis & effective repetition - Empathetic expression, knowing the audience, capturing attention - Creating Memes, Comic Strips, Stand-up comedy, Caption writing, and Limericks, Vocabulary and slang words for comedy - Similes & Metaphors - Homophones, homonyms, alliteration, wordplay

UNIT 2 - FORMAL EXPRESSION 15 Hours

Writing: Action plans, Cover letters, Mind-Mapping, Paragraph writing Logical reasoning - SVA - Advanced level - Style: Clarity, Concision, Coherence, Evocativeness, Efficacious Vocabulary - Conditional Clause - Be verbs- Tenses- advanced - Opening and closing sentences - Action plans, Anecdotal references, order of communication/ narration, complete communication- Wh-questions - Effective beginning and closing - Rhetorical questions - Appraising target audience - Pronunciation, Enunciation, Tone, Pace and Volume. - Writing: SOPs, Research Objectives, Thesis Statement, Indexing, Scholarly Articles, Academic Writing, Executive Summary, Survey Questionnaires, Citations and Bibliography - Reading: Quantitative & qualitative analysis, Analysis and paraphrasing of reference materials Speaking: Commentate live events, give instructions to operate machines/ conduct experiments Listening: Informational listening, Reflective listening, - Discriminative listening - Connective words - Prefixes and Suffixes - Quoting and paraphrasing Proofreading - Directed writing and writing formats - Note taking - Active verbs

Total: 30 Hours

Reference(s)

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001
4. Personality Development, Harold R. Wallace &L.Ann Masters, Cengage Learning, New Delhi
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi
6. English Grammar, Composition and Usage by N. K. Agrawal & F.T.Wood, Macmillan India Ltd., New Delhi

22HS010 SOCIALLY RELEVANT PROJECT **0 0 0 0**

Course Objectives

- To develop Problem-Solving Skills
- To enhance Research and Analytical Abilities
- To promote Social Responsibility and Ethical Awareness

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Identify and document socially relevant issues through structured field interaction and stakeholder engagement.
2. Analyze identified social problems using engineering principles, critical thinking, and available data.
3. Propose technically feasible, cost-effective, and sustainable solutions aligned with societal needs.
4. Collaborate effectively in multidisciplinary teams and interact responsibly with the community.
5. Communicate findings through technical reports and presentations, adhering to ethical and professional standards.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	1	3	2	-	-	-	-	-	-	2	2
2	3	3	-	2	2	3	3	-	-	-	-	-	-	2	-
3	2	3	3	2	3	3	3	-	-	-	-	-	2	3	3
4	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
5	1	-	-	-	2	-	-	-	-	-	-	-	-	2	3

Students have to interact with society, conduct a field survey and identify the issues / problems available in the society. Analyze the issues using engineering knowledge, skills and attitude and provide the optimal solutions to solve the social issues and submit the report.

Total 40 Hours

22ME501 MECHATRONICS **2 0 2 3**

Course Objectives

- To understand the basic knowledge of Microprocessor in mechatronics systems.
- To impart knowledge on working of microcontroller in mechatronic systems.
- To learn the concepts and methods of microcontroller interfacing with hardware.
- To study the functions and interfacing methods of Arduino in mechatronics system.
- To impart the programming of Arduino used in mechatronics system.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the architectural features of the 8085 microprocessors to construct timing diagrams and develop assembly language programs.
2. Analyze the architectural features of the 8051 microcontrollers to classify instructions and design basic interfacing circuits."
3. Construct and simulate interfacing methods for I/O devices, serial communication, ADC/DAC, and integrated circuits using the 8051 microcontrollers.
4. Investigate the effect of pin configurations, platform features, and programming environment of Arduino to model basic hardware-software integration.
5. Design and implement Embedded C programs for interfacing Arduino with sensors, actuators, and communication modules.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	2	2	-	-
3	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
4	2	2	2	2	-	-	-	-	-	-	-	2	2	-	-
5	2	2	2	-	-	-	-	-	-	-	-	2	2	-	-

UNIT I **6 Hours**
MICROPROCESSOR
Introduction to 8085 microprocessor- 8085 Architecture -Instruction set - Addressing modes - Timing diagrams - Assembly language programming - Stack - Interrupts.

UNIT II **6 Hours**
MICROCONTROLLER
Introduction to 8051 microcontroller - Architecture of 8051 - Instruction set - Moving data, Logical, Arithmetic operation, Jump & call instruction, LCD & Keyboard Interfacing.

UNIT III **6 Hours**
INTERFACING AND PROGRAMMING
Memory interfacing - Interfacing I/O devices - Interfacing Serial I/O (8251) - Parallel I/O (8255) - Keyboard / Display controller (8279) - ADC/DAC interfacing - Inter Integrated Circuits interfacing.

UNIT IV **6 Hours**
ARDUINO
Introduction to Arduino - Pin configuration and architecture - Device and platform features - Concept of digital and analog ports - Familiarizing with Arduino Interfacing Board. Arduino and programming software and Hardware Architecture, Integrated development environment of Arduino (IDE).

UNIT V **6 Hours**
MECHATRONICS SYSTEM
Introduction to Embedded C and Arduino platform - Basic functions - Interfacing with sensors, Electromechanical control of servomotor and stepper motor, Interfacing with Bluetooth module.

EXPERIMENT 1 **4 Hours**
Develop a virtual encoder interface with a DC motor to demonstrate real-time position monitoring of robotic arm to optimize path tracing.

EXPERIMENT 2 **4 Hours**
Develop the tracking control program for servo motors in position tracking of solar panels.

EXPERIMENT 3 **4 Hours**
Use Arduino Uno to implement conditional operation for garage car washing sequence.

EXPERIMENT 4 **5 Hours**
Connect the IR sensor to the Arduino and ensure proper orientation and alignment of object transport.

EXPERIMENT 5 **4 Hours**
Design and development of the program to interface the Arduino for Intelligent home locking system.

EXPERIMENT 6 **4 Hours**
Design and develop the program to interface the Arduino for Intelligent water level management system.

EXPERIMENT 7 **5 Hours**

Design and develop the program to interface the Arduino for Intelligent Automatic Irrigation System.

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Total: 60 Hours

Reference(s)

1. Muhammed Ali Mazidi, Rolind D Mckinlay, Danny Causey "Pic Microcontroller and Embedded Systems using Assembly and C for PIC18", Pearson Edition 2021.
2. A. P. Godse, D. A. Godse, "MMicroprocessors and Microcontrollers", Technical Publications 2021.
3. W. Bolton, Mechatronics, Sixth edition, Pearson Education, New Delhi, 2019.
4. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi 2019.
5. Massimo Banzi, "Getting Started with Arduino: The Open Source", Shroff Publishers & Distributors Pvt Ltd, 2014.
6. Ramesh S. Goankar, "Microprocessor Architecture: Programming and Applications with the 8085", Sixth edition, Penram International, 2013.

22ME502 DESIGN OF MACHINE ELEMENTS 3 1 0 4

Course Objectives

- To learn the design procedure of machine elements subjected to steady, variable loads, and simple mechanisms.
- To provide knowledge on the design of joints and flanged, bushed pin type couplings.
- To study the design of helical, torsional, leaf springs and design of sliding and rolling contact bearings.
- To learn the design procedure of spur, worm gears and design of wire rope.
- To learn design of shaft and design of gearbox.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Assess stress-strain behavior of mechanical components under different loading conditions to predict their structural performance
2. Design welded joints and shaft couplings by interpreting load conditions and applying strength criteria for reliable mechanical connectivity.
3. Analyze and design mechanical springs and bearings to ensure functionality and durability under specified operating loads.
4. Apply engineering principles to design gear and belt drive systems such as spur gears, worm gears, and flexible belts for effective power transmission.
5. Infer the functional performance of shafts and develop gearbox configurations to enhance transmission efficiency.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	3	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
4	3	2	2	-	-	-	-	-	-	-	-	-	3	-	-
5	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-

UNIT I **9 Hours**

DESIGN PROCESS AND MECHANISM

Introduction to Design process - Materials Selection - Design for Steady and Variable loading - Bending stress in curved beams. Design of Geneva mechanism, Ratchet and pawl mechanism.

UNIT II **9 Hours**

DESIGN OF JOINTS AND COUPLINGS

Design of bolted joints - stresses due to static and eccentric loading. Design of welded joints - Strength of parallel and transverse fillet weld. Design of Couplings - Flanged and bushed pin type coupling.

UNIT III **9 Hours**

DESIGN OF SPRINGS AND BEARINGS

Introduction and terminology - Design of springs - helical, torsional and leaf springs subjected to static and fatigue loads. Introduction - types and selection criteria - Design of Bearings - sliding contact and rolling contact bearings.

UNIT IV **9 Hours**

DESIGN OF DRIVE SYSTEMS

Need for power transmission - Design of gears - Spur and Worm Gears, Force analysis, Tooth stresses, and Failure. Introduction of flexible elements - Design of wire rope.

UNIT V **9 Hours**

DESIGN OF TRANSMISSION ELEMENTS

Design of Shafts based on strength and rigidity. Design of Gear Box - types, standard step ratio, Ray diagram, Kinematics layout, Calculation of number of teeth and overlapping speed.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2017.
2. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2015
3. R. C. Juvinall and K. M. Marshek, Fundamentals of Machine Component Design, John Wiley & Sons, New Delhi, 2011.
4. R. L. Norton, Design of Machinery, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
5. M. F. Spotts, T. E. Shoup and I. E. Hornberger, Design of Machine Elements Pearson Education, 2006
6. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book, M/s.Kalaikathir Achchagam, 2013.

22ME503 THERMAL ENGINEERING 2 1 2 4

Course Objectives

- To study the components, fuels, Pollutant and performance of internal combustion engines.
- To provide knowledge on Power plant cycles and steam nozzles
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of Cogeneration and waste heat recovery
- To impart knowledge on air compressors and Ventilation
- To apply the thermodynamic concepts into refrigeration and air conditioning systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply thermodynamic principles to evaluate the performance characteristics of single-cylinder and multi-cylinder internal combustion engines using various fuels and emission control techniques.
2. Analyze the thermal performance of modified Brayton and Rankine cycles to enhance work output, and assess nozzle behavior using critical pressure ratios and flow area relationships.
3. Assess cogeneration and waste heat recovery systems by analyzing cycle efficiency, heat exchanger performance, and economic feasibility for sustainable energy utilization.
4. Investigate reciprocating and rotary air compressors with and without clearance volume, to select suitable systems for ventilation applications based on airflow requirements and threshold limits.
5. Design vapor compression refrigeration systems incorporating subcooling and superheating, and apply psychrometric processes to develop effective air conditioning configurations for various applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	2	2	-	2	-	3	-
2	2	3	-	-	-	-	2	-	-	-	-	2	-	3	-
3	3	-	-	-	-	-	-	-	2	2	-	2	-	3	-
4	2	2	2	3	2	-	-	-	2	2	-	2	-	3	-
5	2	2	3	-	2	-	2	2	2	2	-	2	-	3	-

UNIT I **6 Hours**

INTERNAL COMBUSTION ENGINES

Internal combustion engines - Types, Working and Performance. Fuels - alternate fuels, Octane and Cetane Number. Pollutant control techniques, Norms.

UNIT II **6 Hours**

POWER PLANT CYCLES AND NOZZLE

Gas turbine power plant cycle - Brayton cycle, and Modification. Steam power plant cycle - Rankine cycle, and modifications. Nozzles- shapes of nozzles, effect of friction, critical pressure ratio.

UNIT III **6 Hours**

COGENERATION AND WASTE HEAT RECOVERY

Cogeneration Principles - Cycle analysis - Applications - source and Utilization of waste heat - systems - Heat exchangers - Economic analysis.

UNIT IV **6 Hours**

AIR COMPRESSORS AND VENTILATION

Reciprocating compressor - single stage, multi stage. Rotary compressors - Types, Working. Ventilation - Need, threshold limits, ventilation rates, methods.

UNIT V **6 Hours**

REFRIGERATION AND AIR-CONDITIONING

Vapour compression refrigeration cycle - superheat, sub cooling, performance calculations. Vapour absorption system. Psychormetric - Process, Chart - Air conditioning systems-Split, VRV/VRF and central.

EXPERIMENT 1 **4 Hours**

Select and propose suitable valve opening and closing angles and times for a four-stroke diesel well engine and bike two-stroke petrol engine.

EXPERIMENT 2 **4 Hours**

Select and propose suitable lubricating oils (2T oil, SAE2040 oil, coconut oil, and neem oil) based on flash and fire point and viscosity for two-stroke and four-stroke two-wheeler engine.

EXPERIMENT 3 **4 Hours**

Select, propose, and install, suitable pollution control techniques for 4-stroke diesel engines and investigate their emissions.

EXPERIMENT 4 **4 Hours**

Prepare a biodiesel for a 4-stroke diesel engine and investigate its performance of 4-stroke diesel engines.

EXPERIMENT 5 **4 Hours**

Propose a suitable compressor for vehicle spray painting applications and investigate its performance.

EXPERIMENT 6 **5 Hours**

Propose a suitable air conditioner for a seminar hall (Size 40'*40') and investigate its performance.

EXPERIMENT 7 **5 Hours**

Propose a suitable refrigeration system for food preservation and investigate its performance.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. R. K. Rajput, Thermal Engineering, 10th edition, Lakshmi Publications, 2018
2. Mahesh M Rathore, Thermal Engineering, 1st edition, Tata McGraw Hill Education Private Limited, 2010
3. Ed. Frank Kreith, The CRC Handbook of Thermal Engineering, CRC Press LLC, 2000
4. Yunus A Cengel, Robert H Turner and John M Cimbala, Fundamentals of Thermal-Fluid Sciences, 5th edition, McGraw-Hill Education, 2016

22ME504 MACHINING AND METROLOGY 3 0 2 4

Course Objectives

- To learn the metal cutting theory, measure the forces acting on the single point tool and calculate various forces involved in it.
- To familiarize about the construction, working and operations working skills for making simple components in centre lathe. Also provide working skill and knowledge on construction and working of milling and gear cutting machines
- To impart the knowledge on working of drilling, boring machines and provides working skill in drilling machines and fine finishing processes and to provide working skills in grinding machines.
- To learn the method of linear and angular measurements and provides working skill in suitable devices.
- To provide knowledge on form measurements using suitable instruments and advances in metrology for linear geometric dimensions.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Explain the metal cutting theory and calculate the various forces acting on the lathe turning tool using Merchant circle.
2. Select and explain the suitable machine-like lathe milling and gear cutting machines based on the application and make simple components using these machines.
3. Choose the suitable drilling machine, finishing process based on the application and produce simple components using grinding machines
4. Practice the appropriate linear and angular measurements using precision measuring instruments.
5. Examine the major terminologies for screw thread, gear and roundness measurement and apply the advanced techniques in metrology to calculate the geometric dimensions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	-	-	-	1	1	2	1	-	1	3	-	1
2	2	3	-	-	-	-	-	1	2	1	-	1	3	-	1
3	2	2	-	-	-	-	-	1	2	1	-	1	3	-	1
4	2	2	-	-	-	-	-	1	2	1	-	1	1	-	3
5	2	2	-	-	2	-	-	1	2	1	-	1	1	-	3

UNIT I **9 Hours**

METAL CUTTING THEORY

Introduction - Orthogonal, Oblique Cutting and types of chip formation. Mechanisms of metal cutting - Chip thickness ratio and Shear plane. Merchant"s Circle - Deriving the forces, calculations. Cutting tool - Properties and materials, wear. single point tool nomenclature, tool life and its calculations. cutting fluids - properties.

UNIT II **9 Hours**

LATHE, MILLING MACHINE AND GEAR CUTTING MACHINES

Introduction - Types- Centre Lathe - Specification, operations. Mechanisms - Thread cutting. Work holding devices. Milling - Introduction, types, specifications, up milling, down milling and operations. Indexing - simple and differential indexing methods. Gear cutting-gear milling, gear shaper and gear hobbing machine.

UNIT III **9 Hours**

DRILLING, BORING MACHINES AND FINISHING PROCESSES

Drilling - Introduction, types, specifications, construction of universal drilling machine, types of drills and nomenclature of twist drill. Introduction to horizontal boring machine. Finishing processes - Grinding - Introduction and Types. grinding wheel- selection, glazing, loading, dressing and truing. Fine finishing processes - Honing, lapping, buffing and super finishing.

UNIT IV **9 Hours**

LINEAR AND ANGULAR MEASUREMENTS

Introduction - Basics of metrology - Linear Measuring Instruments: Vernier Caliper, Vernier Height and Vernier Depth Gauge, Inside, Outside and Depth Micrometer, Slip Gauge, Limit Gauge - Mechanical Comparator - Angular Measurements: Bevel protractor, Sine bar, Autocollimator

UNIT V **9 Hours**

FORM MEASUREMENTS

Thread Measurement: Terminologies, Errors - Pitch Gauge, Tool Maker"s microscope - Gear Measurement: Terminologies, Errors, Gear Tooth Vernier caliper, Profile Projector - External and Internal Radius measurements - Roundness measurement - Straightness and Flatness Measurement. Coordinate Measuring Machine: Basic concept, Types, Constructional features, Probes, Accessories - Surface Roughness Measurement - Machine Tool Metrology.

EXPERIMENT 1 **4 Hours**

Perform the suitable machining operation to reduce the diameter and to improve the surface finish for the circular shaft used in pumps.

EXPERIMENT 2 **4 Hours**

Select the suitable machining operation to reduce the length of the given component and improve the surface finish of the shaft used in automotive drive shafts.

EXPERIMENT 3 **4 Hours**

For the flange coupling assembly used in conveyor systems, four holes are required with PCD 72mm by using the suitable machining operations to make the required holes.

EXPERIMENT 4 **4 Hours**

Enlarge the diameter of the drilled holes for the shaft used in steering columns of automobiles with the suitable machining operations.

EXPERIMENT 5 **5 Hours**

Make the required steps for fabricating the spur gear by reducing the diameter of the given component for the gear train application.

EXPERIMENT 6 **4 Hours**

Measure the dimensions and its tolerance to ensure the product quality to be used in turbine assembly.

EXPERIMENT 7 **5 Hours**

Develop the flange coupling to transmit power in compressor by the suitable machine tool alignment of lathe/milling/drilling machine.

Total: 75 Hours

Reference(s)

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall India Learning Private Limited., New Delhi, 2013.
2. Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Education Limited., New Delhi, 2014.
3. P. N. Rao, Manufacturing Technology - Metal Cutting and Machine Tools, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2013
4. S. K. Hajra Choudhury, Elements of Workshop Technology. Vol. II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
5. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009.
6. Bewoor, Vinay Kulkarni, Metrology & Measurement, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2009.

22ME507 MINI PROJECT 0 0 2 1

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Identify a technical problem or area of interest and define clear project objectives using domain-specific knowledge.
2. Develop an engineering solution or prototype through research, design, and experimentation.
3. Apply appropriate tools, techniques, and modern software/hardware platforms to implement the project.
4. Function effectively as a team member by sharing responsibilities and adhering to timelines.
5. Demonstrate effective communication and documentation skills through interim reports and presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	1	2	1	1	2	2	2	3	3	2	3
2	2	3	3	3	3	2	1	2	3	2	3	3	3	3	3
3	1	2	3	3	3	2	2	1	3	2	3	3	2	3	3
4	1	2	2	1	1	1	1	2	3	3	3	2	1	1	3
5	1	1	1	1	1	1	1	2	2	3	3	2	1	1	2

22ME508 ADVANCED MODELING LABORATORY 0 0 4 2

Course Objectives

- To expose the knowledge on the surface modeling with rendering & sheet metal components for preparation of product design with catalogue.
- To model the weldments structure using special tools with preparation of fabrication drawing.
- To perform the shape optimization study to reduce the weight for comparative study.
- To apply the knowledge of generative shape design for finding the best design with preparation of product catalogue.
- To obtain the knowledge on static stress analysis report for the given component to find the failure analysis and study the injection molding time study.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Develop 3D surface and sheet metal models using advanced CAD features and generate professional product catalogues for real-world applications.
2. Create weldment-based frame structures and produce detailed fabrication and manufacturing drawings.
3. Apply shape optimization and generative design techniques to improve design efficiency and evaluate manufacturing feasibility.
4. Perform static stress analysis of mechanical components and interpret stress distribution using simulation tools.
5. Design and analyze moulds for plastic injection components by studying timing, gate location, and solidification parameters.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	-	3	-	-	-	1	2	-	-	3	2	2
2	3	2	3	-	3	-	-	-	1	2	-	-	3	2	2
3	3	3	3	2	3	-	2	-	1	2	-	-	3	3	3
4	3	3	-	3	3	-	-	-	1	2	-	-	2	3	2
5	3	3	2	3	3	-	-	-	1	2	-	-	3	3	3

EXPERIMENT 1 **8 Hours**

Prepare the three-dimensional model, rendering of the hair dryer using the surface module and prepare a product catalogue.

EXPERIMENT 2 **8 Hours**

Build an enclosure for the heat pump using the sheet metal module and prepare the drafting and prepare a product catalogue.

EXPERIMENT 3 **8 Hours**

Generate the 3D model of frame structure using the weldments module and prepare a fabrication drawing.

EXPERIMENT 4 **10 Hours**

Create a Shape Optimization study to optimize the shape of a robot gripper arm and reduce the material by 40 percentage and catalogue with comparison study.

EXPERIMENT 5 **10 Hours**

Design the given 3D model and apply the generative shape design then select the best solution for manufacturing the product design and prepare a product catalogue for business marketing.

EXPERIMENT 6 **8 Hours**

Prepare the Static Stress Analysis of a Connecting Rod Assembly and analysis report generation.

EXPERIMENT 7 **8 Hours**

Create a mold and die for the injection molding component and study the injection timing, gate location, and solidification of the plastic component.

Total: 60 Hours

Reference(s)

1. Autodesk fusion-360, Surface Design, 978-1393400349, 2020.
2. Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings, Kishore Publishers, 978-8194195337, 2019.
3. Autodesk Fusion 360, Black Book, CAD/CAM/CAE Works publishers, 978-1988722689, 2019.

22ME601 HEAT AND MASS TRANSFER 2 1 2 4

Course Objectives

- To familiarize conduction heat transfer mechanisms
- To expose the mechanisms of free and forced convection
- To develop the shape factor algebra for black body radiation and grey body radiation
- To demonstrate the phase change heat transfer and calculate the performance of heat exchanging devices
- To explain diffusion and convective mass transfer.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply Fourier's law to study the steady-state heat conduction in simple and composite systems including extended surfaces.
2. Analyze forced and free convection over different surfaces using heat transfer coefficients and non-dimensional numbers.
3. Assess the phenomena of radiative heat transfer between surfaces using radiation laws, shape factors, and radiation shields.
4. Investigate the boiling, and condensation process and analyse the heat exchanger performance using LMTD and NTU methods.
5. Interpret the concept of steady-state molecular diffusion and convective mass transfer by applying Fick's law of mass transfer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	2	-	2	2	-	1	-	2	2
2	2	3	-	-	2	-	2	-	2	2	-	1	-	2	2
3	2	3	-	-	2	-	2	-	2	2	-	1	-	2	2
4	2	2	-	2	2	-	2	-	2	2	-	1	-	2	2
5	2	-	-	-	2	-	2	-	2	2	-	1	-	2	2

UNIT I **7 Hours**

CONDUCTION

Introduction - Steady State Conduction in one and two - dimensional systems. Composite systems. Extended surfaces.

UNIT II **7 Hours**

CONVECTION

Basic concepts - Heat transfer coefficients, Boundary layers. Forced convection - External and Internal flows, correlations, Natural convection.

UNIT III **5 Hours**

RADIATION

Basic laws of radiation - Black body radiation - Grey body radiation - Shape factor algebra - Electrical analogy - Radiation shields.

UNIT IV **6 Hours**

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS

Boiling: Modes - correlations. Condensation: Nusselt theory, correlations. Heat exchangers: heat exchanger analysis, LMTD and Effectiveness - NTU Method.

UNIT V **5 Hours**

MASS TRANSFER

Diffusion mass transfer - Fick's law of diffusion, Steady state molecular diffusion. Convective mass transfer- correlations.

EXPERIMENT 1 **3 Hours**

Measure the thermal conductivity of the metal bar

EXPERIMENT 2 **3 Hours**

Determine the transient heat exchange efficiency of the slab

EXPERIMENT 3 **4 Hours**

Estimate the heat transfer from a cylinder losing heat to the environment

EXPERIMENT 4 **4 Hours**

Analyze the heat transfer by blowing air over the pipe

EXPERIMENT 5 **4 Hours**

Measure the temperature of the surface without contact

EXPERIMENT 6 **4 Hours**

Analyze the parameters required to enhance or promote surface condensation

EXPERIMENT 7 **4 Hours**

Determine heat transfer in heating systems during the exchange of heat

EXPERIMENT 8 **4 Hours**

Determine the overall heat transfer co-efficient for a fluidized bed heat transfer to enhance the efficiency of industrial heat exchanger systems in chemical or energy processes

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. Yunus A.Cengel, Heat and Mass Transfer: Fundamentals and Application, Tata McGraw Hill publishing Company private limited, New Delhi, 6th edition, 2020
2. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 10th edition, 2010
3. C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer, New Age International private limited, New Delhi, Rev.3rd edition, 2006
4. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Principles of Heat and Mass Transfer, ISBN: 978-1-119-38291-1 October 2017
5. R. K. Rajput, Heat and Mass Transfer, S Chand and Company, New Delhi, 2018
6. https://nptel.ac.in/courses/112101097/

22ME602 FINITE ELEMENT ANALYSIS 2 1 2 4

Course Objectives

- To impart basic knowledge in finite element method.
- To provide knowledge in 1D elements.
- To provide knowledge in 2D elements.
- To study heat conduction problems using finite element method.
- To provide knowledge in higher order and iso parametric elements.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Formulate simple finite element problems using appropriate numerical methods.
2. Analyze one-dimensional finite element models to solve bar, beam, and truss problems.
3. Solve plane stress, plane strain, and axisymmetric problems using the finite element method.
4. Evaluate the temperature distribution in one-dimensional and two-dimensional heat transfer problems using finite element techniques.
5. Develop higher-order and isoparametric finite element models using advanced numerical methods.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
2	3	3	2	-	-	-	-	-	-	-	-	1	2	-	-
3	3	3	2	-	-	-	-	-	-	-	-	1	2	-	-
4	3	3	2	-	-	-	-	-	-	-	-	1	2	-	-
5	3	2	2	-	3	-	-	-	-	-	-	1	2	-	-

UNIT I **6 Hours**

INTRODUCTION

Relevance and scope of finite element methods - strain vs displacement relations - stresses and equilibrium - natural and essential boundary conditions - Rayleigh-Ritz - Galerkin method - FEM procedure - Discretisation of domain-element shapes, types, size, location, and numbers.

UNIT II **6 Hours**

ONE-DIMENSIONAL (1D) ELEMENTS

Coordinate system types - global, local and natural. Shape function of 1D bar element - Finite element formulation - stiffness matrix, load vector, boundary condition and assembly of global equation - 1D bar element and two node truss element - problems in the 2D truss. Introduction to beam element.

UNIT III **6 Hours**

TWO-DIMENSIONAL (2D) ELEMENTS

Shape function for linear triangular element - Finite element formulation - Constant Strain Triangular (CST) element - plane stress, plane strain. Axisymmetric elements - problems.

UNIT IV **6 Hours**

HEAT TRANSFER APPLICATIONS

Shape function for 1D and 2D triangular element heat conduction - stiffness matrix, load vector and assembly of the global equation. 1D and 2D triangular element heat conduction, heat generation with convective boundary conditions for the linear element.

UNIT V **6 Hours**

HIGHER ORDER AND ISOPARAMETRIC ELEMENT

Selection of order of polynomial-linear, simplex, complex and multiplex elements. Mesh refinement methods and convergence requirements. Iso, Sub and Super parametric element. Shape functions for a 2-D four noded and eight noded Iso parametric rectangular element - natural coordinate system - problems. Gaussian quadrature method - problems.

EXPERIMENT 1 5 Hours

Design and implement stress, strain, and deformation results to assess the structural integrity and performance of a cycle frame.

EXPERIMENT 2 5 Hours

Evaluate the simulation results to assess the safety, reliability, and performance of bridge trusses.

EXPERIMENT 3 5 Hours

Model and simulate underwater vehicle electronic hull structures using ANSYS Mechanical APDL.

EXPERIMENT 4 5 Hours

Develop finite element models for propeller shafts in all-terrain vehicles using ANSYS Mechanical APDL.

EXPERIMENT 5 5 Hours

Evaluate the impact of thermal stress on the structural integrity of the disc brake..

EXPERIMENT 6 5 Hours

Assess the dynamic behaviour of railway tracks under operational and environmental conditions

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. S. S. Rao, Finite Element Method in Engineering, Elsevier India, 2017.
2. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2017
3. Robert D. Cook, S. David, Malkucs Michael E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley, New Delhi, 2001.
4. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements Engineering, Pearson Education, New Delhi, 2011.
5. S. S. Bhavikati, Finite Element Analysis, New Age International Publishers, 2015.
6. https://archive.nptel.ac.in/courses/112/105/112105308/

22ME603 COMPUTER AIDED MANUFACTURING 2 0 2 3

Course Objectives

- To impart the knowledge on CNC programming basics, interfacing and communication.
- To introduce programming of CNC turning center.
- To introduce programming of CNC machining center.
- To provide knowledge on generic steps of Additive Manufacturing technique.
- To learn the concept and applications of liquid and solid based AM processes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Interpret the constructional features of CNC machines, cutting tools, tool holders, and work holding devices to implement part programs using G and M codes for FANUC and SIEMENS controllers.
2. Apply CNC programming concepts to develop turning programs and demonstrate single-pass, multi-pass cycles for operations for facing, threading, boring, grooving, and drilling. operations
3. Implement CNC machining centre programs by creating tool paths with linear/circular interpolation and machining cycles for pocketing, contouring, drilling, and tapping.
4. Analyze the distinctions between CNC machining and Additive Manufacturing, with respect to CAD modeling, STL file processing, and develop reverse engineering workflows
5. Evaluate liquid, solid, and powder-based additive manufacturing systems and create innovative solutions using open-source 3D printing technologies.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	2	-	2	2	-	1	2	-	2
2	3	-	2	-	2	-	2	-	2	2	-	1	2	-	2
3	3	2	2	2	2	-	2	-	2	2	-	1	2	-	2
4	2	3	3	-	2	-	2	-	2	2	-	1	2	-	2
5	2	2	3	2	2	-	2	-	2	2	-	1	2	-	2

UNIT I **6 Hours**

CONSTRUCTIONAL FEATURES OF CNC

Types of CNC Machines and Constructional features. Cutting Tool Inserts - Materials, Classification, Nomenclature and Selection - Tool holders and Work holding devices - Coordinate system - Structure of a part program - G Codes, M Codes - Programming for FANUC and SIEMENS controller. Graphical user interface - Communication protocol.

UNIT II **6 Hours**

PROGRAMMING OF CNC TURNING CENTRE

Single pass and canned cycle - Turning, facing and threading - Multi-pass canned cycle - rough and finish turning, facing, boring, pattern repeating, threading, drilling, peck drilling, high speed drilling cycle, grooving - Subprogram.

UNIT III **6 Hours**

PROGRAMMING OF CNC MACHINING CENTRE

Machining cycles - Linear and circular interpolation, Contouring, rectangular and circular pocketing, drilling, peck drilling, high speed drilling, tapping, boring, back boring, counter boring.

UNIT IV **6 Hours**

INTRODUCTION TO ADDITIVE MANUFACTURING

Distinction between AM and CNC Machining - CAD Model - Input file formats - Generation and Conversion - Classification of RP. Reverse Engineering - Application of CMM, Laser scanner, CT and MRI scan in acquiring point data - Software for STL file processing.

UNIT V **6 Hours**

LIQUID, SOLID AND POWDER BASED SYSTEMS

Stereolithography Apparatus, Continuous Liquid Interface Production, Fused Deposition Modelling and Laminated Object Manufacturing. Selective Laser Sintering, Electron Beam Melting and Laser Engineered Net Shaping and concept of open source 3D printer - Working Principle, Construction, Materials and Applications.

EXPERIMENT 1 4 Hours

Simulate a custom shaft with tapered ends for use in automotive steering systems or robotic arms.

EXPERIMENT 2 4 Hours

Program and simulate NC machining for creating threaded connections on a pipe fitting used in water pipelines or gas supply systems.

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EXPERIMENT 3 **4 Hours**

Simulate drilling and boring operations for creating cylinder head components with precise boreholes for engines or compressors.

EXPERIMENT 4 **4 Hours**

Simulate and program for creating cam profiles or gears used in machinery or mechatronic systems.

EXPERIMENT 5 **4 Hours**

Design and contour mill a complex mold cavity used in injection molding for producing plastic parts like smartphone casings.

EXPERIMENT 6 **5 Hours**

Design and optimize a lightweight drone arm component for additive manufacturing, focusing on strength-to-weight ratio.

EXPERIMENT 7 **5 Hours**

Design and 3D print a cooling duct for electronics or a small HVAC system using optimized CAD modelling and AM techniques.

Total: 60 Hours

Reference(s)

1. P. Radhakrishnan, S. Subramanyan and V. Raja , CAD/CAM/CIM, New Age International Private Ltd, NewDelhi, 2018.
2. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, 2018.
3. HMT, Mechatronics, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2010.
4. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi, 2008
5. M. M. M . Sarcar, Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2008.
6. Mikell P. Groover, Mitchell Weiss and Roger N. Nagel G Odrey, Industrial Robotics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2007.

22ME607 MINI PROJECT II 0 0 2 1

Course Objectives

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Identify a technical problem or area of interest and define clear project objectives using domain-specific knowledge.
2. Develop an engineering solution or prototype through research, design, and experimentation.
3. Apply appropriate tools, techniques, and modern software/hardware platforms to implement the project.
4. Function effectively as a team member by sharing responsibilities and adhering to timelines.
5. Demonstrate effective communication and documentation skills through interim reports and presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	2	1	2	1	1	2	2	2	3	3	2	3
2	2	3	3	3	3	2	1	2	3	2	3	3	3	3	3
3	1	2	3	3	3	2	2	1	3	2	3	3	2	3	3
4	1	2	2	1	1	1	1	2	3	3	3	2	1	1	3
5	1	1	1	1	1	1	1	2	2	3	3	2	1	1	2

22ME701 INDUSTRIAL ROBOTICS 2 0 2 3

Course Objectives

- To learn the construction and fundamentals of robots.
- To provide knowledge on types of drives and end effectors in robots.
- To impart knowledge on sensors and machine vision system.
- To study the kinematics of robots and its programming method.
- To provide knowledge on the applications of robots in industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

Course Outcomes (COs)

1. Demonstrate the components and construction of a robot manipulator, including its joints, links, and specifications.
2. Analyze the drive mechanisms and end effectors for industrial robots, considering gripper types and force analysis.
3. Investigate the forward and inverse kinematics solutions, and construct programming algorithms for robotic manipulation using DH representation.
4. Develop and simulate basic industrial robot programs using teach pendant, lead through, and proprietary robot languages
5. Integrate the robotic applications in industrial environments, including machining, welding, assembly, and material handling, and plan their implementation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	1	1	-	-	-	-	-	1	-	2	-
2	3	2	-	-	3	1	-	-	-	-	-	1	-	2	-
3	3	2	-	-	3	1	-	-	-	-	-	1	-	1	-
4	3	2	3	-	1	1	-	-	-	-	-	1	-	3	-
5	3	3	3	-	3	1	-	-	-	-	-	2	-	1	-

UNIT I **6 Hours**

FUNDAMENTAL OF ROBOTICS PROCESS

Robot anatomy - Definition, law of robotics, History and Terminology of Robotics - Accuracy and repeatability of Robots - Simple problems - Specifications of Robot - Speed of Robot - Robot joints and Links - Robot classifications - Architecture of robotic systems.

UNIT II **6 Hours**

END EFFECTORS AND ROBOT CONTROLS

Mechanical grippers - Slider crank mechanism, Screw type, Rotary actuators, cam type - Magnetic grippers - Vacuum grippers- Pneumatic grippers - Gripper force analysis - Gripper design - Simple problems - Feedback devices - Encoder, Resolver, LVDT.

UNIT III **6 Hours**

ROBOT KINEMATICS AND PROGRAMMING

Representation of Rigid body motion - DH Representation - Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional) - Derivations and Problems.

UNIT IV **6 Hours**

ROBOT PROGRAMMING

Teach Pendant Programming, Lead through programming, Robot programming Languages - ABB-Rapid Programming - Basics data types - Variables and Constants-Operators - Flow control. KUKA robot - KRL programming - Basic principle of motion programming - KRL syntax - Robo simulation software - Robo analyser software.

UNIT V **6 Hours**

IMPLEMENTATION AND APPLICATION

Implementation of Robots in Industries - Various Steps - Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - hostile and remote environments - Inspection and future application.

EXPERIMENT 1 **5 Hours**

Programming ABB Robot for linear and circular operation of four point with different speed for welding applications.

EXPERIMENT 2 **5 Hours**

Programming of cube path execution using ABB robot through teach pendant for Coating applications.

EXPERIMENT 3 **5 Hours**

Programming of cube path execution using ABB robot through teach pendant for Painting applications.

EXPERIMENT 4 **4 Hours**

Programming of square path execution using blending option in Kuka iiwa 7 axis cobot for surface inspection applications

EXPERIMENT 5 **3 Hours**

Programming of force-controlled screwing operation using KUKA iiwa and sunrise Toolbox for surface cleaning applications

EXPERIMENT 6 **4 Hours**

Programming of automated welding path execution using a 6-Axis Delta Articulated Robot for appliance manufacturing applications.

EXPERIMENT 7 **4 Hours**

Programming of parallel robot for linear operation and circular operation using DRA studio for high-Speed pick and place in the assembly area

Total: 60 Hours

Reference(s)

1. M. P. Groover, Industrial Robotics Technology, Programming and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2nd Edition, 2017.
2. Neil Wilkins, Robotics, Moliva Ab Publishers, 2019.
3. R Mittle, I Nagrath, Robotics and Control, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2017.
4. Kailash Chandra Mahajan, Robotics for Engineers, Vikas Publishing House, Kolkatta, 2016.
5. James G. Keramas, Robot Technology Fundamentals, Cengage Learning, 2011.

22ME702 IoT FOR AUTOMATION 2 0 2 3

Course Objectives

- To Study the fundamentals about IoT.
- To analyze the various protocols of IoT with application development
- To analyze the architecture and framework of IoT Controllers& Cloud Platforms.
- To evaluate the diverse applications of IOT
- To apply IoT for industry and security management applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Understand the IoT fundamentals.
2. Analyse the various protocols of IOT deployed in applications.
3. Design the IoT platform using Raspberry Pi.
4. Execute IoT in desperate applications.
5. Develop IoT concepts for industry applications and security management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2	-	-	-	-	-	-	-	-	1	-	-
2	1	2	3	2	2	-	-	-	-	-	-	-	2	-	-
3	1	3	-	1	2	-	-	-	-	-	-	-	3	-	-
4	3	1	-	1	-	-	-	-	-	-	-	-	3	-	-
5	3	3	2	2	2	-	-	-	-	-	-	-	2	-	-

UNIT I **6 Hours**

GENESIS OF IOT

Things in IoT - Sensors - Actuators- Smart Objects, Sensor Networks - Communication criteria for connecting Smart Objects - Communication models and APIs - IoT levels and Deployment templates - IoT Security and Challenges, Emerging IoT flavours

UNIT II **6 Hours**

IOT ARCHITECTURES AND PROTOCOLS

A Simplified IoT Architecture - Core IoT Functional Stack - Architecture for IoT using mobile technologies - Mobile Technologies for Supporting IoT Ecosystem - Low Power Wide Area Networking Technologies - Infrastructure and Service Discovery protocols - Device Integration protocols

UNIT III **6 Hours**

IOT PLATFORMS AND PROGRAMMING

Embedded computing basics - Microcontroller - System on Chips - Arduino, Beagle Bone Black, Rasberry Pi Interfaces - Programming Rasberry Pi with Python - Developing code for writing to Actuators, Blinking LED, Reading from Sensors, Light Switch

UNIT IV **6 Hours**

DATA ANALYTICS AND CLOUD

An Introduction to Data Analytics for IoT - Role of Machine Learning - Big Data Analytics Tools and Technology - Edge Streaming Analytics and Network Analytics - Cloud Technology. IoT and Cloud inspired smarter environments - Case Studies: Smart and Connected Cities, Healthcare, Agriculture

UNIT V **6 Hours**

INDUSTRIAL IOT AND SECURITY

Introduction to Industrial IoT - Understanding the Industrial IoT Process - Industrial Data Flow and Devices - Security management of an IoT ecosystem - Case studies: Manufacturing- oil and gas - Power utility industry

EXPERIMENT 1 **4 Hours**

Interfacing Automobile Sensors using IoT controller

EXPERIMENT 2 **5 Hours**

IoT-based Engine Speed Control and Monitoring

EXPERIMENT 3 **5 Hours**

IoT Based monitoring and control of fluid transportation (Machine Valve Control)

EXPERIMENT 4 **5 Hours**

Interfacing Material / Object handling system using IoT

EXPERIMENT 5 **5 Hours**

Design of Safety systems for industrial machines

EXPERIMENT 6 **6 Hours**

Interfacing Flexible Manufacturing System using IoT

Total: 60 Hours

Reference(s)

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017.
2. Internet of Things - A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
3. Mohammad Ali Jabraeil Jamali, Bahareh Bahrami, Arash Heidari, Parisa Allahverdizadeh, Farhad Norouzi, Towards the Internet of Things, Architectures, Security, and Applications, Springer International Publishing, 2020.
4. Information Resources Management Association, Smart Cities and Smart Spaces Concepts, Methodologies, Tools, and Applications, IGI Global, 7 September 2018.
5. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.

22ME707 PROJECT WORK I 0 0 4 2

Course Objectives

- To develop skills to formulate a technical project.
- To develop skills to formulate a technical project.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Formulate a real-world engineering problem and define clear project objectives using structured design or research methodologies.
2. Apply core mechanical engineering knowledge, modern tools, and techniques to design, develop, or analyze engineering systems or processes.
3. Demonstrate professional project management skills including planning, execution, documentation, and time management.
4. Work effectively as an individual or in a team to solve complex engineering problems, incorporating social, environmental, and ethical considerations.
5. Communicate project outcomes effectively through well-organized reports, technical documentation, and oral presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	3	2	2	2	2	3	3	3	2
2	3	3	3	3	3	-	-	-	-	-	2	3	3	2	3
3	2	-	-	-	2	3	3	3	3	3	3	2	3	3	3
4	2	2	2	2	3	3	3	3	3	2	3	2	2	2	3
5	-	-	-	-	-	-	-	-	2	3	2	2	2	2	3

22ME801 PROJECT WORK II 0 0 20 10

Course Objectives

- To develop skills to formulate a technical project.
- To develop skills to formulate a technical project.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Formulate a real-world engineering problem and define clear project objectives using structured design or research methodologies.
2. Apply core mechanical engineering knowledge, modern tools, and techniques to design, develop, or analyze engineering systems or processes.
3. Demonstrate professional project management skills including planning, execution, documentation, and time management.
4. Work effectively as an individual or in a team to solve complex engineering problems, incorporating social, environmental, and ethical considerations.
5. Communicate project outcomes effectively through well-organized reports, technical documentation, and oral presentations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	2	3	2	2	2	2	3	3	3	2
2	3	3	3	3	3	-	-	-	-	-	2	3	3	2	3
3	2	-	-	-	2	3	3	3	3	3	3	2	3	3	3
4	2	2	2	2	3	3	3	3	3	2	3	2	2	2	3
5	-	-	-	-	-	-	-	-	2	3	2	2	2	2	3

22HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills
- Increase ability to comprehend complex content
- Enhance confidence in expressing with clarity and elegance
- Enthusiastic and reflective use of the language through sufficient and focused practice
- Articulate fluently and confidently in challenging situations

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply appropriate grammar and vocabulary expected for competitive examinations
2. Analyze the overall intent of non-routine correspondence and short, familiar reports relevant to the work environment.
3. Design clear and routine letters conveying factual information, and prepare notes for common tasks such as managing orders.
4. Create basic presentations or demonstrations aimed at improving comprehension.
5. Infer common visitor needs, articulate standard procedures, and provide guidance on straightforward matters within your job role.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	3	3	-	2	-	-	2
2	2	2	-	-	-	-	-	-	3	3	-	2	-	-	2
3	1	2	2	-	-	-	-	-	3	3	-	2	-	-	2
4	1	2	2	-	-	-	-	-	3	3	-	2	-	-	2
5	2	-	-	-	-	-	-	-	3	3	-	2	-	-	2

UNIT I **15 Hours**

SELF-EXPRESSION

Personal Goals and Values - Being a Team Player-Expressing strengths and Weaknesses-Abstract nouns -Adjectives-Active Listening Skills-Note Making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional Ethics-Reported Speech- Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses- Hypothetical questions and Answers-Sentence Structure-Simple Present Tense-Perfect tense.

UNIT II **15 Hours**

CREATIVE EXPRESSION

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/ services, Giving directions, Process writing, Sequencing experiments, Concept Explanation-Reported Speech-Voice Sentence Equivalence-Proofreading

UNIT III **15 Hours**

FORMAL EXPRESSION

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and Found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication Punctuation - Capitalization, Numeration, Use of proper nouns and Articles-Spelling-Reading: Analyzing and interpreting notices and Circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements Decoding - Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers.

Total: 45 Hours

Reference(s)

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

22HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Demonstrate correct pronunciation of Hindi vowels and consonants and classify them based on sound types (plosives, fricatives, nasals)
2. Apply rules of gender in noun usage and analyze differences between masculine and feminine forms in given texts.
3. Construct grammatically correct sentences using various pronouns and tenses; evaluate and correct sentence structures.
4. Asses classified vocabulary in real-life contexts and analyze relationships between thematic vocabulary groups.
5. Create short dialogues and spoken expressions for real-life situations; evaluate clarity and appropriateness in spoken communication.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3	-	-	-	-	-	2	2	-	2	-	-	2
2	2	3	-	-	-	-	-	-	2	2	-	2	-	-	2
3	3	-	-	-	-	-	-	-	2	2	-	2	-	-	2
4	-	-	-	-	-	-	-	-	2	2	-	2	-	-	2
5	-	-	-	-	-	-	-	-	2	2	-	2	-	-	2

UNIT I **9 Hours**

VOWELS AND CONSONANTS

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

NIT II **9 Hours**

NOUNS

Nouns: Genders -Masculine & Feminine -Reading Exercises

UNIT III **9 Hours**

PRONOUNS AND TENSES

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

UNIT IV **9 Hours**

CLASSIFIED VOCABULARY

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes - Directions -Seasons Professions.

UNIT V **9 Hours**

CONVERSATIONS

Speaking - Telling the times -Saying the Numbers from 1 to 50 Speaking practice for various occasions.

Total: 45 Hours

Reference(s)

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

22HSG01 GERMAN **1 0 2 2**

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Analyze individual German phonemes by carefully listening to identify and differentiate distinct sounds accurately.
2. Apply basic German sounds and vocabulary to develop accurate pronunciation and speaking skills.
3. Develop reading comprehension by understanding short passages on familiar topics in German.
4. Design simple written texts using basic sentence structures effectively in German.
5. Illustrate the fundamental grammar and appropriate vocabulary to complete a variety of language tasks accurately.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	-	-	-	-	-	-	2	2	-	2	-	-	2
2	3	-	-	-	-	-	-	-	2	2	-	2	-	-	3
3	1	2	3	-	-	-	-	-	2	2	-	2	-	-	1
4	1	2	3	-	-	-	-	-	2	2	-	2	-	-	1
5	2	-	-	-	-	-	-	-	2	2	-	2	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country –nationalitie

UNIT V **9 Hours**

IMPLEMENTATION

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

Total: 45 Hours

Reference(s)

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

22HSJ01 JAPANESE 1 0 2 2

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply knowledge of the Japanese alphabet by recognizing and writing basic characters accurately.
2. Develop speaking skills by using basic sounds of the Japanese language in everyday contexts.
3. Formulate the appropriate vocabulary to engage in simple conversations in Japanese.
4. Design grammatically correct sentences by applying essential grammar rules in both written and spoken Japanese.
5. Analyze spoken Japanese conversations to comprehend contextual meaning, recognize key expressions, and respond appropriately in real-life communication scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	2	2	-	2	-	-	3
2	1	2	3	-	-	-	-	-	2	2	-	2	-	-	1
3	1	3	-	-	-	-	-	-	2	2	-	2	-	-	1
4	1	2	3	-	-	-	-	-	2	2	-	2	-	-	1
5	2	2	-	-	-	-	-	-	2	2	-	2	-	-	2

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II **9 Hours**

TIME EXPRESSION / VERBS - PAST

Introduction to time -Introduction of verbs -Listening to specific information

UNIT III **9 Hours**

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation. Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V **9 Hours**

CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours

Reference(s)

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

22HSF01 FRENCH 1 0 2 2

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply knowledge of the French alphabet and basic vocabulary to enhance familiarity with foundational language elements.
2. Analyze individual French sounds by listening carefully to distinguish and identify phonetic components.
3. Create the basic French sounds and vocabulary in spoken interactions to develop oral proficiency.
4. Develop reading comprehension skills by engaging with short passages on familiar topics.
5. Design accurate responses in French by applying grammar rules and appropriate vocabulary while completing language tasks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	2	2	-	2	-	-	2
2	2	3	-	-	-	-	-	-	2	2	-	2	-	-	2
3	-	-	3	-	-	-	-	-	2	2	-	2	-	-	2
4	-	-	3	-	-	-	-	-	2	2	-	2	-	-	2
5	-	-	3	-	-	-	-	-	2	2	-	2	-	-	2

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu. Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

UNIT III **9 Hours**

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

1. Grammaire Progressive du Francais, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette
4. Reussir le DELF A1 Bruno Girardeau
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001

22ME001 CONCEPTS OF ENGINEERING DESIGN 3 0 0 3

Course Objectives

- To provide knowledge on fundamental engineering principles and problem identification.
- To acquire knowledge about concept generation and concept selection.
- To learn the detailed design process and design of manufacture and assembly.
- To impart knowledge on planning for manufacture and design review.
- To impart knowledge on report preparation and intellectual property right.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the principles and interfaces of engineering design to construct a Product Design Specification (PDS) for a defined engineering problem.
2. Analyze structured ideation techniques such as brainstorming and morphological analysis to generate and evaluate creative design concepts using decision matrices.
3. Demonstrate the ability to integrate decision-making models with design for manufacturing, assembly, and environment in the engineering design process.
4. Design cost-effective manufacturing plans using QFD, value engineering, safety factors, and ISO quality concepts for optimized material selection and production.
5. Develop professional design reports and presentation techniques while recognizing the significance of intellectual property rights and patenting processes in engineering design.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	-	-	-	1	2	-	1
2	2	3	-	-	-	-	2	-	-	-	-	1	2	-	1
3	2	2	2	-	-	-	-	-	-	-	-	1	2	-	1
4	2	2	2	-	-	-	2	-	-	-	-	1	2	-	1
5	2	2	2	-	-	-	-	-	-	-	-	1	2	-	1

UNIT I **9 Hours**

PRINCIPLES AND PROBLEM IDENTIFICATION

Engineering design- introduction and definition, Considerations of a good design, Engineering design interfaces, Principles of engineering design, Problem identification, Design process, Product Design Specification (PDS) criteria, Content of a PDS, Codes of ethics, Solving ethical conflicts.

UNIT II **9 Hours**

CONCEPT GENERATION AND SELECTION

Identifying customer needs, Benchmarking, Societal considerations in engineering, Creativity and problem solving, creativity methods - Brainstorming, Morphological analysis, Concept selection - Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, Computer aided decision making.

UNIT III **9 Hours**

DESIGN PROCESS

Detailed description of design process, Design Drawings, Computer Aided Engineering, Designing of standards, Concurrent Engineering, Human Factors in Design, Design for manufacturing (DFM), Design for Assembly (DFA), Industrial design, Design for environment, engineering design principles.

UNIT IV **9 Hours**

PLANNING FOR MANUFACTURE

Quality function deployment (QFD), Quality Assurance, Design review, Value analysis/engineering, Factor of safety, Materials selection, break even analysis - problem, cost evaluation, Elements of cost, ISO concepts, Classification of Manufacturing Process.

UNIT V **9 Hours**

REPORT PREPARATION AND INTELLECTUAL PROPERTY RIGHTS

Presentation Techniques - Introduction, Concept sketches, Scheme drawing, Design Validation, Design report. Intellectual Property Rights - Introduction, Patent, Trademark, copyright, Patentability, Non patentable, patenting process, forms for filing patents.

Total: 45 Hours

Text Book(s)

1. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, 2020.
2. George E Dieter, Engineering Design, Tata McGraw Hill publishing Company Pvt Ltd, New Delhi, 2008
3. Danlel E. Whitney, Mechanical Assembles: Design Manufacture and Role in Product Development, Oxford University, Press, 2008
4. K. Otto, Product Design, Pearson Publications, 2005.
5. Richard Birmingham, Graham Cleland, Robert Driver and David Maffin, Understanding Engineering Design, Prentice Hall of India, 1997
6. Karl T. Ulrich and Steven D. Eppinger Product Design and Development McGraw Hill Edition 7th edition 2020

22ME002 COMPOSITE MATERIALS AND MECHANICS 3 0 0 3

Course Objectives

- To provide fundamental knowledge in reinforcement and matrix materials.
- To impart knowledge on polymer matrix composites.
- To expose the characteristics and different fabrication techniques on polymer and metal matrix composites.
- To impart knowledge on ceramic matrix composites.
- To provide knowledge on the micro mechanism of composites.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Illustarte the need, characteristics, and constituents of composite materials including types of reinforcements, forms, and matrix materials.
2. Apply suitable processing techniques for polymer matrix composites to meet functional and industrial requirements.
3. Assess the characteristics, processing methods, and applications of metal matrix composites using the rule of mixtures and reinforcement effects.
4. Develop the ceramic matrix composites using advanced processing techniques for high-temperature and aerospace applications.
5. Analyze laminated composite structures considering mechanical behavior, failure theories, and structural performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
3	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	2	2	3	2	-	-	-	-	-	-	-	-	-	2	-
5	2	3	-	-	-	-	-	-	-	-	-	2	-	2	-

UNIT I **9 Hours**

INTRODUCTION TO COMPOSITES

Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and nonoxide fibers, Forms of reinforcements - Roving, Woven fabrics, non-woven, random mats, whiskers, Matrix materials - Polymers - Thermosetting resins, thermoplastic resins, Metals, Ceramic materials

UNIT II **9 Hours**

POLYMER MATRIX COMPOSITE

Processing of polymer matrix composites- hand lay-up, Spray lay-up processes, Compression molding-SMC Reinforced reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Applications of polymer matrix composites.

UNIT III **9 Hours**

METAL MATRIX COMPOSITES

Characteristics of MMCs, Various types of Metal matrix composites, Advantages and limitations of MMCs, Effect of reinforcements on properties-Volume fraction - Rule of mixtures, Processing of MMCs - Liquid state processing- stir casting, squeeze casting, infiltration, solid state processing - Powder metallurgy, Diffusion bonding, In-situ processes, applications of MMCs.

UNIT IV **9 Hours**

CERAMIC MATRIX COMPOSITES

Need for CMCs, Processing of CMCs- cold pressing and sintering, hot pressing, infiltration, chemical vapor deposition and chemical vapor impregnation, sol-gel and polymer pyrolysis, high temperature synthesis properties and applications in aerospace and space fields. Introduction to carbon carbon matrix composites.

UNIT V **9 Hours**

MECHANICS FAILURE ANALYSIS AND DESIGN

Characteristics of Fiber-reinforced Lamina-Laminates- Interlaminar stresses-Static Mechanical Properties-Fatigue and Impact Properties-Failure Predictions-Failure Theories-Laminate Design Consideration-Classical lamination Theory-Analysis of Laminated Composite Beams- Plates - Shells Vibration and Stability Analysis- Finite Element Method of Analysis-Analysis of Sandwich structures.

Total: 45 Hours

Reference(s)

1. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, Marce Dekker Inc, 2007
2. K. Autar Kaw, Mechanics of Composite Materials, CRC Press, 2013.
3. B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, Joh Wiley and Sons, New York, 2017.
4. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2016.
5. K.K. Chawla, Composite materials, Springer Verlag, 2012
6. Robert M. Jones, Mechanics Of Composite Materials, CRC Press,2018.

22ME003 COMPUTER AIDED DESIGN 3 0 0 3

Course Objectives

- To provide knowledge of fundamentals of CAD and geometric transformations.
- To understand the various geometric modeling concepts
- To identify the common visual realism algorithms.
- To impart the knowledge on parts assembly logics and consideration factors.
- To study the available data exchange formats for CAD model transportation.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Interpret CAD/CAM/CAE fundamentals, product cycle models, and geometric transformations with projections in computer graphics applications.
2. Construct geometric models using curves (Hermite, Bezier, B-Spline), surfaces, and solids by employing 2D drafting and 3D modeling software.
3. Differentiate graphics display devices and algorithms for hidden line, surface, and solid removal, along with shading, coloring, and animation techniques.
4. Apply assembly modeling concepts including constraints, degrees of freedom, and tolerance analysis to advanced modeling techniques such as freeform modeling, generative design, and rendering.
5. Evaluate CAD data exchange formats, database standards, and communication protocols for ensuring interoperability across CAD/CAE/CAM systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
4	3	2	2	2	-	-	-	-	-	-	-	-	2	-	-
5	2	2	-	3	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

FUNDAMENTALS

Introduction to CAD/CAM/CAE, Graphics Input devices-cursor control Devices, Digitizers, Keyboard terminals, Image scanner, Speech control devices and Touch, panels, Product cycle, Sequential and Concurrent Engineering, CAD - Architecture, Tools, applications - Coordinate systems - Two and Three-dimensional Transformations - Translation - Scaling - Reflection - Rotation, Windowing - clipping and Viewing, Orthographic and perspective projections.

UNIT II **10 Hours**

CURVES AND GEOMETRIC MODELING

Representation of curves, Properties of curve design and representation, - Hermite, Bezier, B-Spline and rational curves, Surface Modeling, surface patch, Bezier and B spline surface. Fundamentals of Solid Modelling, Boundary representation and Constructive Solid Geometry, Sweep representation, Comparison of wireframe, surface and solid models, Basic application commands for 2D drafting software like AutoCAD & 3D solid modeling software like Solidworks, Autodesk Inventor, PTC Creo, Catia etc.

UNIT III **9 Hours**

VISUAL REALISM

Graphics display devices, Cathode Ray Tube, Random & Raster scan display, Color CRT monitors, Direct View Storage Tubes, Flat Panel display, Hard copy printers and plotters, Coherence types. Hidden line removal algorithm, Priority and Area oriented algorithms. Hidden Surface removal algorithm, Depth buffer and Warnock''s algorithms. Hidden solid removal algorithm, Ray Tracing algorithm, Shading and Coloring, types. Computer Animation.

UNIT IV **8 Hours**

ASSEMBLY MODELING AND ADVANCED MODELING TECHNIQUES

Assembly modeling, Interference of Positions and orientations, CAD Tolerance Analysis, geometrical Mass Properties, degree of freedom, Constraints and Simulation concepts. Introduction to freeform modeling, rendering, generative design, technical drawing.

UNIT V **9 Hours**

DATA EXCHANGE FORMATS

Database Management System, CAD Standards, File types, DXF, STL, STEP, IGES, PDES, PARASOLID, ACIS, Data, Database Structures, Types. Communication Standards, Data Exchange between CAD/CAE/CAM Systems, Requirements for the Exchange, Exchange Methods.

FOR FURTHER READING

Graphics manipulation and Editing, Parametric Representation of Synthetic Curves, Applications of CAD in FEM.

Total: 45 Hours

Reference(s)

1. Ibrahim Zied, CAD/CAM-Theory and Practice, Tata McGraw Hall Publishing Company Pvt. Ltd., New Delhi, 2009.
2. Donald Hearn, M. Pauline Baker, Computer Graphics, Prentice Hall of India, New Delhi, 2014.
3. Richard M. Lueptow, Graphics Concepts for Computer-Aided Design, Pearson Education, India, 2nd edition, 2007.
4. William M. Neumann, Robert F. Sproul, Principles of Computer Graphics, Tata McGraw Hall Publishing Company Pvt Ltd., New Delhi, 2005.
5. Mikell P. Groover, Emory W. Zimmers, CAD/CAM Computer-Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2007.
6. https://www.autodesk.com/certification/learn/course/fusion360-generative-design-intro-expert

22ME004 MECHANICAL VIBRATIONS 3 0 0 3

Course Objectives

- To learn the fundamental concept of vibration of a single degree of freedom (DOF) system.
- To expose knowledge on vibration of Two DOF systems.
- To expose knowledge on vibration of the Multi- DOF system.
- To learn the governing equation of vibration of continuous systems.
- To describe various instruments and control methods used in vibration analysis.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply the fundamental principles of mechanical vibrations to model and interpret the behavior of single degree of freedom systems under free and forced conditions within a defined mechanical context.
2. Analyze two-degree freedom systems using concepts such as mode shapes, coordinate coupling, and orthogonality to predict system response under various excitation conditions.
3. Formulate mathematical models for multi-degree freedom systems and solve for natural frequencies and mode shapes using exact and approximate methods within the course timeline.
4. Demonstrate the vibration characteristics of continuous systems like strings, rods, and beams by applying analytical methods such as Rayleigh's and Rayleigh-Ritz method.
5. Design vibration measurement and control systems using appropriate sensors, transducers, and signal processing tools to monitor and interpret mechanical vibrations in practical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
2	2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
3	2	2	-	3	-	-	-	-	-	-	-	-	-	3	-
4	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
5	2	-	3	2	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

SINGLE DEGREE OF FREEDOM (SDF)

Fundamentals of vibration. Single Degree of Freedom - Responses of undamped free vibration - Viscous damping - Damped free vibration - Reponses of undamped forced vibration and damped forced vibration - Response of damped system under base excitation - Rotating unbalance.

UNIT II **9 Hours**

TWO DEGREE FREEDOM SYSTEM (TDF)

General equation of motion - Principal mode of vibration - Coordinate coupling - Orthogonolity principle - Rectilinear and torsional systems - Natural frequencies of undamped free vibration systems - Equations of motion for forced vibrations and damped free vibration - Dynamic vibration absorber - Lagrange"s equation

UNIT III **9 Hours**

MULTI-DEGREE FREEDOM SYSTEM (MDF)

Modelling of MDF systems by equations of motion from Newton"s law - Influence coefficients - Stiffness coefficients and Generalised coordinate - Eigenvalue problems and solution. Approximate methods in MDF, Dunkerley"s method, matrix iteration method, Rayleigh"s and Holzer"s method.

UNIT IV **9 Hours**

VIBRATION OF CONTINUOUS SYSTEMS

Introduction - Transverse vibration of string - axial vibration of a rod - Torsional vibration of shaft - Lateral vibration of beam - Rayleigh"s Method and Rayleigh-Ritz method.

UNIT V **9 Hours**

VIBRATION MEASUREMENT AND CONTROL

Vibration Measuring Devices: seismometer, accelerometer and velometers-Vibration exciters: mechanical, hydraulic, electromagnetic and electrodynamic-Frequency measuring instruments: single reed, multi reed and stroboscope. Vibration meters and sound level meters. Signal conditioning devices: Filters, Amplifiers, Modulators/Demodulators, ADC/DAC. Signal analysis devices. Vibration recording and display devices

Total: 45 Hours

Reference(s)

1. Rao, S. S. Mechanical Vibrations, Pearson Education, 2011.
2. William Thomson, Marie Dillon Dahleh, Theory of Vibrations with Applications, Pearsons Education 2014.
3. Graham Kelly G and Shashidar K. Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007.
4. D.J Inman, Engineering Vibration, Pearson International Education, 2014.
5. https://www.youtube.com/@introductiontomechanicalvi2886/videos.

22ME005 ENGINEERING TRIBOLOGY 3 0 0 3

Course Objectives

- To impart basic knowledge on friction and wear
- To provide knowledge on behavior of surface contacts
- To learn about frictional behavior of sliding and rolling contacts
- To learn the wear mechanisms and its consequences under different contact conditions
- To identify the appropriate lubrication method based on contact conditions

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Assess the fundamental concepts of friction and wear to apply their influence on mechanical interactions.
2. Apply surface contact characteristics to evaluate the suitability of bearings in specified engineering applications.
3. Infer the role of friction in tribological systems to enhance performance and reduce energy loss.
4. Analyze wear mechanisms and quantify wear rates to assess material performance under operational conditions.
5. Interpret lubrication requirements and correlate them with suitable lubricant types for specific tribological applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
5	3	2	-	-	-	-	2	-	-	-	-	-	2	1	-

UNIT I **7 Hours**

INTRODUCTION

Introduction to Tribology, Factors influencing Tribological phenomena, Properties of materials relevant to friction and wear.

UNIT II **9 Hours**

CONTACT BEHAVIOUR OF SURFACE

Engineering surfaces - Surface characterization, Contact of engineering surfaces: Hertzian and nonhertzian contact, Contact pressure and deformation in non-conformal contacts.

UNIT III **9 Hours**

FRICTION

Causes of friction, Stick-slip friction behavior and friction instability, sliding and rolling friction, frictional heating and temperature rise, Friction measurement techniques.

UNIT IV **9 Hours**

WEAR AND ITS MEASUREMENT

Wear and wear types, Mechanisms of wear, wear of metals and non-metals. wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage, wear measurement and controlling techniques.

UNIT V **11 Hours**

LUBRICATION

Lubricants- physical and chemical properties, types of additives. Selection of lubricants, Hydrodynamic lubrication-principle and application, Reynolds equation. Elasto hydrodynamic Lubrication- Principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin Equation.

Total: 45 Hours

Reference(s)

1. Prasanta Sahoo, Engineering Tribology, 3rd edition, Prentice-Hall India, New Delhi, 2011.
2. Bharat Bhushan, Introduction to Tribology, 2nd edition, Wiley Publication, 2013.
3. I.M. Hutchings, Friction and Wear of Engineering Material, Edward Arnold, London, 2002.
4. Neale, M.J., Bearings-Tribology Hand Book, Butterworth Heinemann, 2005.
5. T.A. Stolarski, Tribology in Machine Design, Industrial Press Inc., 2000.
6. http://www.nptel.iitm.ac.in/downloads/110105039/

22ME006 FAILURE ANALYSIS AND DESIGN 3 0 0 3

Course Objectives

- To familiarize with various failure modes and examine the failed components
- To study the fractures in materials and compare the different theories of fractures
- To analyse the dynamic fracture and determination of fracture toughness values
- To know importance of tribology in the design, friction, wear, and wear measurements
- To predict the failure modes and the principles of utilizing the tools for failure analysis

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Analyze material failures, use suitable testing methods, and select appropriate materials and processes for effective and reliable design under various conditions.
2. Apply fracture mechanics to study ductile and brittle failures, evaluate crack growth using elastic and plastic methods, and assess structural safety using key fracture parameters.
3. Assess the dynamic and time-dependent fracture behavior in materials, and determine fracture toughness using experimental methods such as K-R curve testing, J-integral, and CTOD measurements.
4. Investigate different types of wear and their failure mechanisms, evaluate wear behavior under various conditions including elevated temperatures, and assess the effects of friction, creep, and environmental factors on material performance.
5. Develop reliability concepts and statistical tools such as Poisson, exponential, and Weibull distributions to predict and extend system life, and perform failure analysis using FMEA and fault tree analysis for identifying and ranking failure modes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
4	3	2	-	-	-	-	-	1	-	-	-	1	2	-	-
5	3	2	1	-	-	-	-	1	-	-	-	1	2	-	-

UNIT I **10 Hours**

MATERIALS AND DESIGN

Introduction, causes of failures, classification, steps in failure analysis, tools, sample selection and treatment, materials analysis, equipment, Metallography, commonly used NDT methods. Effect of component geometry and shape factors, designing with high strength and low toughness materials, designing for hostile environments; Materials selection in design; Processes and their influence on design, systematic process selection.

UNIT II **9 Hours**

FRACTURE MECHANICS

Ductile fracture, brittle fracture, cleavage-fractography, ductile-brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach; Time dependent crack growth and damage; Linear elastic fracture mechanics: Griffith theory, energy release rate, instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, crack growth instability analysis, crack tip stress analysis; Elastic plastic fracture mechanics: Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD.

UNIT III **8 Hours**

FRACTURE TOUGHNESS

Dynamic fracture, rapid loading of a stationary crack, rapid crack propagation, dynamic contour integral, creep crack growth-C Integral, viscoelastic fracture mechanics, viscoelastic J integral; Determination of fracture toughness values: Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing.

UNIT IV **9 Hours**

WEAR FAILURES

Types of wear, different methods of wear measurement, analysis of wear failures, wear at elevated temperatures, wear of different materials, role of friction on wear, stick slip friction, creep, stress rupture, elevated temperature fatigue, environment induced failure.

UNIT V **9 Hours**

FAILURE ANALYSIS TOOLS

Reliability concept and hazard function, life prediction, life extension, application of Poisson, exponential and Weibull distributions for reliability, bath tub curve, parallel and series systems, MTBF, MTTR, FMEA-design FMEA, process FMEA, analysis of causes of failure modes, ranks of failure modes; Fault tree analysis; Industrial case studies on FMEA.

Total: 45 Hours

Reference(s)

1. Anderson T L , "Fracture Mechanics: Fundamentals and Applications", 4th Edition, Taylor and Francis, 2017.
2. Shigley and Mische , "Mechanical Engineering Design", 5th Edition, McGraw Hill, 2011.
3. John M Barsoom and Stanley T Rolte , "Fracture and Fatigue Control in Structures", 3rd Edition, American Society For Testing & Materials, 1999.
4. Balbir S. Dhillon , "Applied Reliability and Quality: Fundamentals, Methods and Procedures", 1st Edition,Springer Series in Reliability Engineering, 2010.
5. ASM Metals Handbook Volume 11 , "Failure Analysis and Prevention", 10th Edition, ASM International, 2002.

22ME007 DESIGN OF AUTOMOTIVE SYSTEMS 3 0 0 3

Course Objectives

- To explore various types of engineering materials
- To design various components in a I.C. engine
- To learn the design procedures for different type of gears
- To study the design process of a crankshaft
- To familiarize the students in design of flywheel

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Interpret endurance limit, notch sensitivity, tolerances, interference fits, and failure theories (Rankine, Tetmajer, Johnson) to support engineering material selection and design considerations.
2. Select appropriate materials and estimate dimensions for the design of cylinders, pistons, and connecting rods considering mechanical loads and lubrication constraints.
3. Analyze the design parameters of spur and helical gears by applying Lewis and velocity factors to determine static, dynamic, and wear strengths.
4. Investigate the mechanical loading on crankshafts and develop balanced crankshaft configurations including crank arms and end details.
5. Determine the dimensions and stress distribution in flywheel components by applying turning moment diagrams and moment of inertia concepts to ensure consistent engine performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

ENGINEERING MATERIALS

Engineering materials - Introduction endurance limit, notch sensitivity. Tolerances, types of tolerances and fits, design considerations for interference fits, surface finish, surface roughness, Rankines formula - Tetmajers formula - Johnson formula.

UNIT II **9 Hours**

DESIGN OF CYLINDER, PISTON AND CONNECTING ROD

Choice of material for cylinder and piston, design of cylinder, piston, and piston pin, piston rings, piston failures, lubrication of piston assembly. Material for connecting rod, determining minimum length of connecting rod, small end design, shank design, design of big end cap bolts.

UNIT III **9 Hours**

DESIGN OF GEARS

Spur Gears Nomenclature, Standard involute gears, Beam strength of tooth, Lewis equation, Form factor & velocity factor, Stress in gear teeth, Dynamic loads on gear teeth, Wear Strength. Helical Gears Nomenclature, Formative number of teeth, Helix angle, Face width, Velocity factor, Static Strength, Dynamic strength, and Wear strength.

UNIT IV **9 Hours**

DESIGN OF CRANKSHAFT

Balancing of I.C. engines, MI of Crankshaft, significance of firing order. Material for crankshaft, design of crankshaft under bending and twisting, balancing weight calculations, development of short and long crank arms. Front and rear-end details.

UNIT V **9 Hours**

DESIGN OF FLYWHEEL

Determination of the mass of a flywheel for a given co-efficient of speed fluctuation. MI of flywheel, Engine flywheel - stresses on the rim of the flywheels. Design of hubs and arms of the flywheel, turning moment diagram

Total: 45 Hours

Reference(s)

1. Giancarlo Genta, Lorenzo Morello , "The Automotive Chassis Volume 1, Components Design", 1st Edition, Springer International Edition, US,2014.
2. Donald E. Malen , "Fundamentals of Automobile Body Structure Design", 1 st Edition, SAE International, US, 2011.
3. Heinz Heisler , "Vehicle and Engine Technology", 2nd Edition, SAE International, 2011.
4. Smith J.H , "An Introduction to Modern Vehicle Design", Anniversary edition, Butterworth-Heinmann, US,2002.
5. Robert C. Juvinall and Kurt M. Marshek , "Fundamentals of Machine Component Design", 6 th Edition, Wiley, 2017.
6. Wolfgang Matschinsky , "Road Vehicle Suspensions", 1 st Edition, Wiley, US, 1997.

22ME008 DESIGN OF TRANSMISSION SYSTEMS 3 0 0 3

Course Objectives

- To study the design procedure of belt and rope drive
- To learn the design procedure of spur and helical gear drives
- To learn the design procedure of bevel and worm gear drives
- To study the design procedure of multistage gear box
- To familiarize the students for design of I.C. Engine Components

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the design principles to identify the specifications of flexible power transmission elements such as belts and wire ropes.
2. Design spur and helical gear through force analysis, stress evaluation, and failure criteria for power transmission applications.
3. Interpret the bevel and worm gear systems based on the geometry of gear, type of loading, and failure modes for efficient power transmission.
4. Develop the step ratio, kinematic arrangement, ray diagram, and gear teeth specifications for the design of multistage gearboxes employed in industrial applications.
5. Analyze the design of motion-converting mechanisms and internal combustion engine components, such as pistons and connecting rods, by applying fundamental design concepts.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	3	-	-	-	-	-	-	-	-	1	2	-	-
2	3	2	3	-	-	-	-	-	-	-	-	1	2	-	-
3	3	2	3	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	3	-	-	-	-	-	-	-	-	2	2	-	-
5	3	2	3	-	-	-	-	-	-	-	-	1	2	-	-

UNIT I **9 Hours**

DESIGN OF FLEXIBLE ELEMENTS

Need for power transmission - Types and classification of transmission systems, Applications, Limitations. Belt drives - Types, materials and construction, Selection of flat and V-belts from manufacturer catalogue. Wire Ropes- Construction, Rope lay, Stresses in wire rope, Failure of ropes.

UNIT II **9 Hours**

DESIGN OF SPUR AND HELICAL GEARS

Spur and Helical gears- Introduction, Gear design, Force analysis, Tooth stresses - Failure in gears.

UNIT III **9 Hours**

DESIGN OF BEVEL AND WORM GEARS

Bevel Gear- Introduction, Types, Geometry, Angle relations, Basic dimensions, Force analysis. Worm Gear -Introduction, Types, Geometry, Basic dimensions - Forces on worm and worm wheel - Modes of failures.

UNIT IV **9 Hours**

DESIGN OF GEAR BOXES

Gear Box - Geometric progression - Standard step ratio - Ray diagram - Kinematics layout. Design of multi stage gear boxes, Calculation of number of teeth and overlapping speed.

UNIT V **9 Hours**

DESIGN OF MECHANISMS AND I.C. ENGINE COMPONENTS

Design of Ratchet & pawl mechanism and Geneva mechanism. Design of I.C engines components such as piston and connecting rod.

Total: 45 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.
2. L. Norton, Design of Machinery, Fifth Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2013.
3. T. J. Prabhu, Design of Transmission Elements, Mani Offset, Chennai, 2015.
4. B. J. Hamrock, B. Jacobson and S. R. Schmid, Fundamentals of Machine Elements, Third Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2014.
5. S. G. Kulkarni, Machine Design, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2010.
6. https://archive.nptel.ac.in/courses/112/105/112105234/

22ME009 DESIGN OF HEATING VENTILATION AND AIR CONDITIONING **3 0 0 3**

Course Objectives

- To provide knowledge about types and working of heating, ventilation and air conditioning system components.
- To familiarize about the heat gain / loss in a building space to estimate heat load requirements
- To impart knowledge on components required for air distribution system
- To study the different types of chillers, cooling towers, pumps required for chilled water circulation
- To provide awareness on equipment selection and erection of HVAC system

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the basic principles of air conditioning and refrigeration systems to interpret psychrometric properties and processes for different HVAC types.
2. Analyse the heat load in buildings by estimating the heat gains in indoor/outdoor conditions, envelope exposure, and internal/external.
3. Design air distribution systems by selecting and sizing ducts, diffusers, and ventilation components based on air flow requirements and building layout
4. Interpret the components and layout of chilled water systems including chillers, pumps, and piping arrangements to assess flow performance and system efficiency.
5. Select suitable HVAC equipment such as AHUs, FCUs, chillers, and cooling towers, and plan their installation and drafting for efficient system operation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
2	2	3	-	-	-	-	-	-	-	-	-	2	-	-	2
3	2	2	2	-	-	-	-	-	-	-	-	2	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	2	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO HVAC

Air conditioning systems - Concept and Principle, Types - Window, Split Air conditioning, VRV, Central Air Conditioning System. Refrigeration - Refrigerant cycle, Refrigerant - Types, Evaporating & Condensing properties. Psychometric chart - Cooling, Heating, Humidification Methods, Dehumidification Methods, Properties of Air (DBT, %RH, WBT, DPT, ENTHALPY)

UNIT II **9 Hours**

HEAT LOAD ESTIMATION

Basics of Heat transfer in a building envelop. Understanding of Outdoor / Indoor Conditions, Temperature Requirements. Heat Load - Exposure of Wall, Latitude of Location, Yearly Range, Daily Range, Factors effecting the loads estimate. Heat Gain and Loss - Internal and External Sources and Calculations

UNIT III **9 Hours**

DESIGN OF AIR DISTRIBUTION SYSTEM

Components of Air distribution system - Ducts, Diffusers, Vanes - Types, Selection, Requirements and Calculations. Duct designing methods and Fan Selection. Ventilation - Types, Components. Exhaust System - Kitchen and Parking ventilation in case of fire

UNIT IV **9 Hours**

CHILLED WATER SYSTEM DESIGN

Introduction to Chilled and Hot water system - Chiller - Classification and Arrangements. Cooling Tower - Types and Arrangements. Pump and its classification - water velocity calculations. Piping - Fitting, Components, Valves and Friction Losses.

UNIT V **9 Hours**

EQUIPMENT SELECTION AND ERECTION

Classification and Selection - AHU&FCU, Chiller, Condenser, Cooling Tower, Expansion Tank. Detailing and Installation - Chillers, Air handling units, Package units, Fan coil units and Condensing units. Drafting of HVAC Systems.

Total: 45 Hours

Reference(s)

1. W. Larsen Angel , HVAC Design Sourcebook, Tata McGrawhill, Second Edition, 2020
2. Roger Haines, Lewis Wilson, HVAC Systems Design Handbook, McGraw-Hill Education, 5th edition, 2009
3. Herbert W. Stanford III, HVAC Water Chillers and Cooling Towers: Fundamentals, Application, and Operation, CRC Press, Second Edition, 2017
4. Robert McDowall, Fundamentals of HVAC Systems, Elsevier Science, CBS Publishers and Distributors pvt Ltd, Second Edition, 2006
5. Mohsen Sheikholeslami Kandelousi, HVAC System. Intechopen, 2018
6. Design Guide for Heating, Ventilating, and Air Conditioning Systems, U.S. Department of the Interior Bureau of Reclamation, 2006

22ME010 ADVANCED CASTING AND FORMING PROCESSES 3 0 0 3

Course Objectives

- To understand the concept design of gating in casting process.
- To impart knowledge on special casting processes like investment, centrifugal, die casting, and continuous casting.
- To understand the concept of theory of metal forming processes.
- To understand the working principle of bulk deformation processes.
- To expose the methods of sheet metal forming operations and powder metallurgy.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Design an efficient gating and risering system for sand moulding by applying principles of casting design and defect control.
2. Select appropriate casting processes for a given component and justify the use of advanced casting techniques based on process characteristics and applications.
3. Apply metallurgical principles to analyze slip, twinning, and mechanisms of plastic deformation under varying metal forming conditions.
4. Choose and evaluate suitable bulk deformation processes such as forging, rolling, extrusion, and drawing based on application requirements and force calculations.
5. Apply the principles of conventional and high energy rate forming (HERF) processes to select suitable presses and analyze sheet metal formability and powder metallurgy applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	-	-	-	-	-	-	2	2	-	-
2	3	2	2	-	-	-	-	-	-	-	-	2	2	-	-
3	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
4	3	2	1	-	-	-	-	-	-	-	-	2	2	-	-
5	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-

UNIT I **7 Hours**

CASTING DESIGN

Introduction - Principles and Design considerations in casting, Elements of a gating system, design of gating and risering, designing for directional solidification - casting defects, causes and its inspection - hot coating, cold coating and warm coating.

UNIT II **10 Hours**

ADVANCED CASTING PROCESSES

Investment casting, Shell mould casting, Continuous casting process-Reciprocating moulding process, direct chill process, materials, defects and its applications. Centrifugal casting- Types of centrifugal casting, calculation of rotation speed of the mould equipment. Die casting - types, dies for permanent mould castings, machines, design consideration for die casting and low pressure die casting.

UNIT III **6 Hours**

THEORY OF METAL FORMING

Metallurgical aspects of metal forming - slip twining - mechanics of plastic deformation - effects of temperature - strain rate - microstructure and friction in metal forming - spring back effect - yield criteria and their significance - classification of metal forming processes.

UNIT IV **10 Hours**

BULK DEFORMATION PROCESSES

Forging and Rolling - Introduction, classification, equipment types, die design and its types, press tools, processes, parameters and force calculation. Classification of extrusion processes tool, equipment and principle of these processes - influences of friction - Extrusion force calculation - Defects and analysis - Rod/wire drawing tool equipment and principle of processes - defects - Tube drawing and sinking processes - Mannesmann processes of seamless pipe manufacturing.

UNIT V **12 Hours**

SHEET METAL FORMING AND POWDER METALLURGY PROCESSES

Classification - conventional and HERF processes - Presses - types and selection of presses formability - diagram formability of sheet metals - Principle, process parameters equipment and application of the following processes - Deep drawing, spinning - stretch forming, plate bending, press brake forming Explosive forming - electro hydraulic forming - magnetic pulse forming - Powder Metallurgy Technique - Advantages - applications - Powder preform forging - powder rolling Tooling, process parameters and applications.

Total: 45 Hours

Reference(s)

1. Jain P. L, Principles of Foundry Technology, Tata McGraw Hill Publications, New Delhi, 2014.
2. Heine R.W, Carl Loper and Rosenthal P.C, Principles of Metal Casting, Tata McGraw Hill Publications, New Delhi, 2012.
3. J. P. Kaushish, Manufacturing process., Prentice Hall of India Learning Private Limited, second edition, New Delhi, 2015
4. Dieter G. E, Mechanical Metallurgy, Tata McGraw Hill Company, New Delhi,2015
5. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of learning, New Delhi, 2015

22ME011 NON-TRADITIONAL MACHINING PROCESSES 3 0 0 3

Course Objectives

- To introduce basics of non-traditional machining processes.
- To study the mechanical energy based non-traditional machining processes.
- To provide knowledge on electrical energy based non-traditional machining process
- To impart knowledge on chemical and electro-chemical energy based processes.
- To impart knowledge on thermal energy based machining processes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the basic principles of non-traditional machining processes to the indicate its need and classification.
2. Illustrate the working principles, equipment, and process parameters of mechanical energy-based machining processes such as AJM, WJM, and USM.
3. Interpret the working principles, power circuits, and tool-material interactions involved in Electrical Discharge Machining and Wire EDM for conductive material machining.
4. Assess the electro-chemical and chemical machining techniques for their precision, material suitability, and machining efficiency.
5. Analyze the use of thermal energy-based machining processes (LBM, EBM, PAM) for cutting hard-to-machine materials in advanced manufacturing scenarios.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	1	2	-	-
2	3	-	-	-	-	-	2	-	-	-	-	1	2	-	-
3	3	-	-	-	-	2	2	-	-	-	-	1	2	-	-
4	3	3	-	-	-	2	2	-	-	-	-	1	2	-	-
5	3	2	-	-	-	2	2	-	-	-	-	1	2	-	-

UNIT I **7 Hours**

INTRODUCTION

Introduction - Need - Classification - Energies employed in the processes – Working principles, Advantages, Limitations, Applications of Abrasive jet machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (EBM), Electro-chemical machining (ECM), Electron beam machining (EBM), Laser beam machining (LBM), Plasma arc machining (PAM).

UNIT II **10 Hours**

MECHANICAL ENERGY BASED PROCESSES

Abrasive Jet Machining, Water Jet Machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications, High pressure abrasive water jet machining

UNIT III **10 Hours**

ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM, EDM drill-Applications.

UNIT IV **10 Hours**

CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES

Chemical machining-Etchants, Maskants techniques. Electro-chemical machining - - Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical honing - Applications.

UNIT V **8 Hours**

THERMAL ENERGY BASED PROCESSES

Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate-Applications.

Total: 45 Hours

Reference(s)

1. P. K. Mishra, Non Conventional Machining, Narosa Publishing House, New Delhi, 2018
2. P. C. Pandey and H.S.Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2021.
3. Joao Paulo Davim, Nontraditional Machining Processes: Research Advances, Springer, NewYork, 2013.
4. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
5. Vijaya Kumar Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi,2023.
6. Hassan El-Hofy, Advanced Machining Processes: Non-traditional and Hybrid Machining Processes, McGraw-Hill Professional, New Delhi, 2005

22ME012 WELDING TECHNOLOGY 3 0 0 3

Course Objectives

- To study the principles of welding process, gas welding, arc welding and their applications
- To provide knowledge on resistance welding process, parameters and its applications.
- To study the solid-state welding process, parameters and its applications
- To know about special welding process and the welding automation for mass production.
- To learn the welding metallurgy, design and testing of weldments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Explain the principles, types, and applications of gas welding and arc welding processes.
2. Apply the concepts of welding metallurgy in the design and testing of weldments to ensure structural integrity and performance.
3. Demonstrate understanding of solid-state welding processes, including their working principles, parameters, and practical uses.
4. Evaluate special welding processes and assess the role of welding automation in enhancing mass production efficiency.
5. Analyze the process parameters and industrial applications of various resistance welding techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	1	2	-
5	3	2	2	-	-	-	-	-	-	-	-	-	1	2	-

UNIT I **9 Hours**

WELDING PRINCIPLES, DESIGN, GAS AND ARC WELDING PROCESSES

Classifications of Welding Processes - Power sources, Arc characteristics, V-I characteristics, Metal transfer modes, electrodes and fluxes. Types of Weld joints, Weld position, Welding symbols. Gas welding Types, Arc welding: Shielded Metal Arc Welding (SMAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW/MIG), Submerged Arc Welding (SAW), Flux Cored Arc welding and Plasma Arc Welding (PAW) - Advantages, limitations and its applications, Welding Defects.

UNIT II **9 Hours**

RESISTANCE WELDING PROCESSES

Spot welding (RSW), Seam welding (RSEW), Projection welding (PW), Resistance Butt welding, Flash Butt welding (FW), Percussion welding, High frequency resistance welding process and High frequency induction welding process - Advantages, limitations and its applications.

UNIT III **9 Hours**

SOLID STATE WELDING PROCESSES

Forge welding (FOW), Friction welding (FRW), Explosive welding (EXW), Ultrasonic welding (USW), Cold welding (CW), Diffusion bonding (DFW), Roll welding (ROW) and Hot pressure welding (HPW) processes - Advantages, limitations and its applications.

UNIT IV **9 Hours**

SPECIAL WELDING PROCESSES AND WELDING AUTOMATION

Thermit welding (TW), Atomic Hydrogen welding (AHW), Electron beam welding (EBW), Laser Beam welding (LBW), Friction stir welding (FSW), Under Water welding, Wire Arc Additive Manufacturing, Cladding, Welding automation in aerospace and automobile industry.

UNIT V **9 Hours**

WELDABILITY, TESTING OF WELDMENTS, CODES AND STANDARDS

Weldability of Aluminium, Copper, Cast Iron and Stainless steels. Destructive tests: Tensile Test, Bend Test, Impact Test, Hardness Testing, Fatigue Test. Non-destructive testing: Visual Inspection, Liquid Penetrant Testing, Magnetic Particle Testing, Radiographic Testing and Ultrasonic Testing of weldments. Codes and Standards: Introduction to codes and standards, Welding and Welder Qualification, Procedure Qualification Record (PQR), Welding Procedure Specification (WPS), and Welder Performance Qualification (WPQ).

Total: 45 Hours

Reference(s)

1. David H. Phillips, Welding Engineering: An Introduction, Wiley, 2016
2. Parmer R.S., Welding Engineering and Technology, 3rd edition, Khanna Publishers, New Delhi, 2022
3. Parmer R.S., Welding Processes and Technology, Khanna Publishers, New Delhi, 2004.
4. Nadkarni S.V., Modern Arc Welding Technology, 1st edition, Oxford IBH Publishers, 2008.
5. AWS Welding Hand Book, Welding Process, 10th Edition, Vol- 1&2, 201

22ME013 PROCESS PLANNING AND COST ESTIMATION 3 0 0 3

Course Objectives

- To introduce the process planning concepts.
- To impart the importance of cost estimation process and procedures.
- To study the procedure to calculate direct, indirect and overhead expenses. To learn the procedure to estimate the various machine costs.
- To learn procedure to estimate the machining time for Lathe, drilling, boring, shaping, milling and grinding operations.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply process planning principles to select appropriate materials, machines, and production methods for manufacturing operations.
2. Assess the objectives, importance, and procedures of cost estimation and distinguish between costing and estimation techniques.
3. Compute various cost elements including direct, indirect, overhead expenses, and depreciation using standard methods.
4. Estimate the production cost in forging, welding, gas cutting, and foundry operations considering material, labour, and overhead costs.
5. Calculate the machining time for common machining operations such as turning, drilling, boring, shaping, milling, and grinding.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	1	1	1	1	-
2	3	2	-	-	-	-	-	-	-	-	1	1	1	1	-
3	2	2	2	-	-	-	-	-	-	-	1	1	1	2	-
4	3	2	2	-	-	-	-	-	-	-	2	1	1	2	-
5	3	2	2	-	-	-	-	-	-	-	1	1	1	2	-

UNIT I **9 Hours**

PROCESS PLANNING

Definition - Objective - Scope - Process planning activities - Approaches - Manual, Computer Aided Process planning - Retrieval, Generative and Semi- generative - Selection processes - Machine selection - Material selection parameters - Set of documents for process planning. Production time calculation - Selection of cost optimal processes.

UNIT II **8 Hours**

INTRODUCTION TO COST ESTIMATION

Objectives and functions of Estimating - Costing - Importance and aims of Costing - Difference between Costing and Estimation - Methods of Costing - Types of estimates - Methods of estimates - Importance of Realistic Estimates - Estimating procedure.

UNIT III **8 Hours**

ELEMENTS OF COST

Introduction - Material Cost - Direct and Indirect - Labour cost - Direct, Indirect and Determination of Direct Labour Cost - Expenses - Direct and Indirect - Analysis of overhead expenses - Administrative expenses - Selling and Distributing expenses - Allocation of overhead expenses- Depreciation - Causes and methods of depreciation.

UNIT IV **10 Hours**

PRODUCTION COST ESTIMATION

Estimation in forging shop - Losses in forging and forging cost - Problems - Estimation in Gas cutting and welding shop - Material cost, Labour cost and Finish on cost -Problems - Estimation in foundry shop - Pattern cost, Foundry cost and casting cost - Problems

UNIT V **10 Hours**

ESTIMATION OF MACHINING TIME

Importance of machine time calculations - Estimation of machining time for Lathe, drilling, boring, shaping, milling and grinding operations - Problems

Total: 45 Hours

Reference(s)

1. R. Kesavan, E.Elanchezhian, B.Vijaya Ramnath, Process planning and cost estimation, New Age International Publications, 2019.
2. S. K. Mukhopadhyay, Production Planning and Control-Text and cases, Prentice Hall of India Private Limited, 2015.
3. Chitale.A.C., Gupta.R.C., Product Design and Manufacturing, Prentice Hall of India Private Limited, 2020
4. Peter scallan, Process planning, Design/Manufacture Interface, Elsevier science technology Books,2020

22ME014 COMPUTER INTEGRATED MANUFACTURING 3 0 0 3

Course Objectives

- To introduce the basic concepts of Computer Integrated Manufacturing (CIM).
- To provide knowledge on Group Technology and Computer Aided Process Planning
- To impart knowledge on Shop Floor Control and Flexible Manufacturing Systems.
- To learn the various CIM implementation and data communication techniques.
- To provide knowledge on the concept of Manufacturing automation protocol, Technical office protocol and database terminology.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Interpret the evolution of manufacturing and management systems, differentiate between dedicated and open systems, and explain CAD/CAM integration with communication protocols.
2. Illustrate parts using GT coding systems (DCLASS, MICLASS, OPITZ), analyze process planning approaches, and apply computer-aided process planning for cellular manufacturing.
3. Demonstrate shop floor control and data collection methods, and evaluate FMS components, layouts, and material handling systems for improving manufacturing flexibility.
4. Apply system modeling tools such as IDEF and activity cycle diagrams, and analyze CIM implementation strategies, architectures, and data communication techniques including LAN topologies.
5. Investigate open system standards (MAP/TOP), develop relational database models, and evaluate database applications to enhance data management in CIM environments.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
2	3	2	2	-	-	-	-	-	-	-	-	1	2	-	-
3	3	2	2	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	2	-	-	-	-	-	-	-	-	1	2	-	-
5	2	2	2	3	-	-	-	-	-	-	-	1	2	-	-

UNIT I **8 Hours**

INTRODUCTION

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems, manufacturing automation protocol, introduction to CAD/CAM integration

UNIT II **10 Hours**

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. - Benefits of G.T - cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT III **9 Hours**

SHOP FLOOR CONTROL AND FMS

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection system. FMS- components of FMS- types -FMS workstation-material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

System modelling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) - manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) -topology -LAN implementations - network management and installations.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol-(MAP/TOP). Development of databases - database terminology - architecture of database systems- data modeling and data associations -relational data bases - database operators - advantages of data base and relational database

Total: 45 Hours

Reference(s)

1. Mikell P Groover,Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD,CAM,CAE systems, Addison Wesley, United States of America, 1999.
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003.
4. Radhakrishnan P, Subramanyan S and Raju V, CAD,CAM,CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000.

22ME015 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To develop the ability to generate 3D CAD models using different methods.
- To explain and apply the constructional features of CNC machines and develop programs for simple components.
- To provide comprehensive knowledge of generic processes and benefits of Additive Manufacturing (AM).
- To familiarize students with materials and process parameters in liquid- and solid-based AM techniques.
- To explore powder-based methodologies, emerging trends, and case studies in AM applications across industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply CAD modeling techniques (wireframe, surface, and solid modeling) to design mechanical components using Constructive Solid Geometry (CSG) and Boundary Representation (B-rep) methods.
2. Analyse CNC machine operations and formulate G-code programs for turning and milling operations using linear and circular interpolation.
3. Develop an understanding of additive manufacturing (AM) processes and analyse their advantages over traditional CNC machining.
4. Design and develop 3D models for AM by converting CAD files into STL format, verifying and repairing them for defect-free part fabrication.
5. Analyse different AM systems and apply them in reverse engineering, medical, automotive, aerospace, and electronics industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	1
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	1
3	3	2	3	-	-	-	-	-	-	-	-	-	2	-	1
4	2	2	3	2	3	-	-	-	-	-	-	-	2	-	1
5	2	2	2	2	3	-	-	-	-	-	-	-	2	-	1

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **9 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automation. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **9 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **9 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications Application of Additive Manufacturing in Manufacturing, Automotive industries and Aerospace industries

UNIT V **9 Hours**

POWDER BASED PROCESSES

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2022.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2018.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2015.
5. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, 2015.

22ME016 ADDITIVE MANUFACTURING 3 0 0 3

Course Objectives

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes
- To impart knowledge on powder based AM processes.
- To introduce the concept of open source 3D printers and rapid tooling
- To expose the emerging trends and applications of Additive Manufacturing technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Interpret the working principles and process parameters of various additive manufacturing techniques within engineering contexts.
2. Investigate diverse applications of additive manufacturing processes across industrial sectors.
3. Formulate suitable material-process combinations for fabricating functional products using additive manufacturing.
4. Apply material science knowledge to analyze and justify material selection for AM components.
5. Design and develop innovative product models optimized for additive manufacturing processes within course timelines.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	2	-	-	-	-	-	-	-	2	-	2
2	2	3	1	-	2	-	-	-	-	-	-	-	2	-	2
3	2	2	3	-	2	-	-	-	-	-	-	-	2	-	2
4	3	2	1	-	2	-	-	-	-	-	-	-	2	-	2
5	2	2	3	-	2	-	-	-	-	-	-	-	2	-	2

UNIT I **9 Hours**

INTRODUCTION TO ADDITIVE MANUFACTURING

Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM. Vat Photo polymerization AM Processes: Stereo lithography (SL), Materials, Process Modelling, SL resin curing process, SL scan patterns, Micro-stereo lithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photo polymerization, Material Jetting and Binder Jetting AM Processes. Solid Ground Curing (SGC) Principle processes parameters Process details - Machine details - Advantages and Limitations.

UNIT II **9 Hours**

EXTRUSION-BASED AM PROCESSES

Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes, case studies. Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications, case studies.

UNIT III **9 Hours**

POWDER BED FUSION AM PROCESSES

Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, case studies.

UNIT IV **9 Hours**

DIRECTED ENERGY DEPOSITION AM PROCESSES

Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, Relationships, Benefits, Drawbacks, Applications of Directed Energy Deposition Processes. Additive friction stir deposition process, Functionally graded additive manufacturing components. Case studies.

UNIT V **9 Hours**

DESIGN FOR ADDITIVE MANUFACTURING (DFAM)

Design for Additive Manufacturing (DfAM): Introduction to geometric modelling, Modelling of Synthetic curves like Hermite, Bezier and B-spline, Parametric Representation of freeform surfaces, Design freedom with AM, Need for Design for Additive Manufacturing (DfAM), CAD tools vs. DfAM tools, Requirements of DfAM methods, General Guidelines for DfAM, The Economics of Additive Manufacturing, Design to Minimize Print Time, Design to Minimize Post-processing.

Total: 45 Hours

Reference(s)

1. 1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
2. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, 2015.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2019.
4. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

22ME017 / 22MEH17 NON DESTRUCTIVE TESTING 3 0 0 3

Course Objectives

- To learn different surface inspection techniques
- To provide knowledge on sub surface testing methods.
- To impart knowledge on ultrasonic testing method.
- To provide knowledge on radiography testing method.
- To study various special non-destructive testing methods.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply visual inspection and liquid penetrant testing methods to detect surface discontinuities in engineering components.
2. Analyze subsurface flaws in materials using magnetic particle testing and eddy current inspection techniques.
3. Asses ultrasonic testing techniques, including phased array and angle beam methods, to evaluate internal defects in structural and welded components.
4. Illustrate radiographic testing procedures using X-rays and gamma rays to interpret film and digital radiographic data for internal defect characterization.
5. Develop appropriate testing approaches using acoustic emission, infrared thermography, leak testing, and laser-based techniques for advanced applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	2	-	-	-	-	-	-	-	1	-	2	-
2	3	2	-	2	-	-	-	-	-	-	-	1	-	2	-
3	3	-	-	2	-	-	-	-	-	-	-	1	-	2	-
4	3	-	-	2	-	-	-	-	-	-	-	1	-	2	-
5	3	2	-	2	-	-	-	-	-	-	-	1	-	2	-

UNIT I **9 Hours**

SURFACE TECHNIQUES

Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, Visual or Optical Testing - Direct and remote visual inspection and Aides. Liquid Penetrant Testing (LPT) Principles - Types and properties of liquid penetrants and developers - Preparation of test materials - Advantages and limitations - Application of penetrants to parts - Fluorescent penetrant test

UNIT II **9 Hours**

SUB SURFACE TECHNIQUES TESTING

Magnetic Particle Testing (MPT) - Principles, applications, magnetization methods, magnetic particles - Dry particle technique and Wet fluorescent particle technique - Advantages and Limitations. Eddy Current Inspection - Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations

UNIT III **9 Hours**

ULTRASONIC TESTING

Ultrasonic Testing (UT) - Principle, Types and characteristics of Ultrasonic waves - Attenuation, Couplants, Probes - Inspection methods - Pulse echo, Transmission and Phased Array techniques (PAUT), Types of scanning and displays - Angle beam inspection of welds - Calibration of ASTM Test blocks, International Institute of Welding IIW) reference blocks - Applications

UNIT IV **9 Hours**

RADIOGRAPHY TESTING

Radiographic testing (RT) -Principle, Sources of X-rays and Gamma rays and their characteristics - Absorption, scattering, Filters and screens, imaging modalities - Film radiography and Digital Radiography - Problems in shadow formation, Exposure factors, film handling and storage- Inverse square law, Exposure charts, and Radiographic equivalence, Penetrometers - Safety in radiography- Applications

UNIT V **9 Hours**

SPECIAL NDT TECHNIQUES

Acoustic Emission Testing (AET) Principle - Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) - Principle, Techniques and applications. Leak Testing - Principle, Testing Procedure and applications. LASER Stereography- Typical applications- Requirements - advantages and disadvantages.

Total: 45 Hours

Reference(s)

1. Charles J. Hellier, "Handbook Of Nondestructive Evaluation", McGraw-Hill Education; 3rd edition 2020.
2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, 2009
3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001.
4. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., 1997.
5. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995.
6. https://onlinecourses.nptel.ac.in/noc19_mm07/course

22ME018 / 22MEM18 OPERATIONS MANAGEMENT 3 0 0 3

Course Objectives

- To understand the concept of production and operations management.
- To familiarize the various forecasting techniques.
- To make the decision on capacity and location planning.
- To impart the knowledge on aggregate planning and master scheduling.
- To emphasize the need of material management and inventory control.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply operations management principles to identify production system types, evaluate productivity factors, and solve decision-making problems using appropriate models and techniques.
2. Apply appropriate forecasting techniques to assess time series data, forecast accuracy, and support decision-making in operations management.
3. Analyze capacity and location planning decisions by evaluating influencing factors, measuring requirements, and assessing alternative solutions to optimize operational efficiency.
4. Investigate aggregate planning strategies and master scheduling methods to align production capabilities with demand while optimizing resource utilization and operational efficiency.
5. Analyze the components of materials management and inventory control systems to evaluate inventory models and enhance the efficiency of purchasing, storage, and material planning decisions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
2	3	2	-	-	2	-	-	-	-	-	2	1	2	-	-
3	3	2	-	-	-	-	-	-	-	-	-	1	2	-	-
4	3	2	-	2	2	-	-	-	-	-	2	1	2	-	-
5	3	2	-	2	2	-	-	-	-	-	2	1	2	-	-

UNIT I **9 Hours**

OPERATIONS MANAGEMENT

Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.

UNIT II **9 Hours**

FORECASTING

Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast.

UNIT III **9 Hours**

CAPACITY AND LOCATION PLANNING

Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout, need for layout decisions, types of processing.

UNIT IV **9 Hours**

AGGREGATE PLANNING AND MASTER SCHEDULING

Aggregate planning, Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning, graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

UNIT V **9 Hours**

MATERIALS MANAGEMENT AND INVENTORY CONTROL

Material Management, Components of Integrated Material Management, Materials planning, Inventory Control, Purchase Management, Stores Management; Inventory control, Models of Inventory controls, Purchase model , Manufacturing model.

Total: 45 Hours

Reference(s)

1. R. Panneerselvam, Production and Operations Management, PHI, 2018.
2. R.B. Khanna, Production and operations management, PHI, 2015.
3. Jay Heizer, Barry Render, Operations Management, Pearson College Division, 2013.
4. N. Chary, Production and operations management, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
5. Joseph G Monks, Operation Management, McGrew Hill Publication, International Edition, 1987.
6. Everett E. Adams, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India Publications, Fourth Edition, 1989.

22ME019 / 22MEM19 SUPPLY CHAIN MANAGEMENT 3 0 0 3

Course Objectives

- To understand the individual processes of supply chain management and their inter relationships within individual companies and across the supply chain
- To understand the components of supply chain management
- To understand the tools and techniques useful in implementing supply chain management
- To understand the concept of retail logistics and contemporary issues.
- To understand the concept of ware house management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Demonstrate the application of logistics and supply chain management tools and techniques in practical scenarios.
2. Develop effective plans for retail distribution logistics systems considering demand patterns and delivery constraints.
3. Implement order management and reverse logistics strategies in alignment with operational efficiency goals.
4. Analyze the impact of logistics drivers and evaluate contemporary practices to optimize supply chain performance.
5. Integrate warehouse functions into overall logistics systems to enhance inventory flow and service levels.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	2	-	-	-	-	2	-	1
2	2	2	3	-	-	2	-	3	-	-	2	-	2	-	1
3	3	-	-	-	1	-	-	-	-	-	-	-	2	-	1
4	2	3	-	-	-	-	-	-	-	-	-	-	2	-	1
5	2	2	3	-	-	1	2	2	-	-	-	-	2	-	1

UNIT I **9 Hours**

INTRODUCTION

Concepts of Supply Chain and Logistics - Elements of Supply Chain - Elements of Logistics - Manufacturing Supply Chain - Functions of Manufacturing Supply Chain - Retail Supply Chain - Functions of Retail Supply Chain - Scope of Retail Logistics - Retail Supply Chain Management.

UNIT II **9 Hours**

MANAGING RETAIL LOGISTICS

Retail Distribution - Retail Replenishment - Direct Store Delivery - Managing Retail Home Delivery - IT for Retail distribution and replenishment - Measures for Retail Distribution and replenishment - Retail Transport - Transport Management Using IT - Green Transport.

UNIT III **9 Hours**

ORDER MANAGEMENT AND REVERSE LOGISTICS

Order Management - Process - Concept of perfect order - Perfect order measures - Multichannel logistics - Retail Return and reverse logistics - Return Policy - Return Process - Designing reverse supply chain Network - Reverse Logistics Challenges - Application for Reverse Management.

UNIT IV **9 Hours**

RETAIL LOGISTICS AND CONTEMPORARY ISSUES

Managing retail shrinkage - Elements and causes of shrinkage - Shrinkage reduction - Green retailing - Green Logistics - Green Infrastructure - Green IT - Managing Logistics Service Provider - 3PLs/LSPs - Services outsourced to LSP/3PL - Major drivers of logistics outsourcing - Benefits of using 3PL/LSP - Evolution of 4 PL.

UNIT V **9 Hours**

WAREHOUSE MANAGEMENT

Cross Docking - Cross Docking Functions - Necessary ingredients for Cross Docking - Advantages - Warehouse Process Maturity Model - IT in warehouse Management - Retail Warehousing - Basic Functions of retail Warehouse - Value added services of a Retail Warehouse.

Total: 45 Hours

Reference(s)

1. Kuldeepak Singh, A Handbook on Supply Chain Management: A practical book which quickly covers basic concepts & gives easy-to-use methodology and metrics for day-to-day problems, challenges, and ambiguity faced by executives in decision making, Notion Press, 1st Edition, 2021.
2. Chopra Kalra, Supply Chain Management Pearson Education India, 6th Edition, 2016.
3. Sunil Chopra, Peter Meindl, Dharam Vir Kalra, Supply Chain Management, Pearson Education, 7th Edition, 2018.
4. Bowersox, Supply Chain Logistics Management, McGraw Hill Education, 4th Edition, 2018.
5. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Ravi Shankar, Designing & Managing the Supply Chain, 1st Edition 2022.
6. Roberta S. Russell, Bernard W. Taylor, Venkataramanaiah Saddikuti, Pavan Kumar Gudavalleti, Operations and Supply Chain Management, Wiley, 10th Edition, 2023.

22ME020 / 22MEM20 TOTAL QUALITY MANAGEMENT 3 0 0 3

Course Objectives

- To learn concepts, dimension quality and philosophies of TQM
- To study the TQM principles and its strategies
- To learn the seven tools of statistical quality and management
- To impart knowledge on TQM tools for continuous improvement
- To introduce an international quality management system

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Illustrate the fundamental principles, philosophies, and historical evolution of Total Quality Management to implement continuous process improvement.
2. Apply effective strategies for leadership, customer satisfaction, employee involvement, and supplier partnerships to enhance organizational quality culture.
3. Analyze process variations and performance using statistical quality control tools such as control charts and capability studies to ensure product consistency.
4. Develop and apply tools like Benchmarking, QFD, TPM, and FMEA to solve quality-related issues and improve product and process performance.
5. Design quality management systems in accordance with ISO standards and audit requirements to ensure organizational compliance and continuous improvement.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	2
2	2	-	-	-	-	-	-	2	-	-	-	2	1	-	2
3	2	3	-	-	-	-	-	-	-	-	-	2	1	-	2
4	2	2	3	-	-	-	-	2	-	-	-	2	1	-	2
5	1	2	3	-	-	-	-	-	-	-	-	2	1	-	2

UNIT I **9 Hours**

INTRODUCTION

Definition of Quality - Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Obstacles to TQM - Quality Statements - Strategic Planning - Deming Philosophy - Crosby philosophy - Continuous Process Improvement - Juran Trilogy - PDSA Cycle - 5S - Kaizen.

UNIT II **9 Hours**

TQM PRINCIPLES

Principles of TQM - Leadership Concepts - Role of Senior Management - Quality Council - Customer satisfaction - Customer Perception - Customer Complaints - Customer Retention - Employee Involvement - Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal - Benefits - Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating.

UNIT III **9 Hours**

STATISTICAL PROCESS CONTROL (SPC)

The seven tools of quality - Statistical Fundamentals - Measures of Central Tendency and Dispersion - Population and Sample - Normal Curve - Control Charts for variables X bar and R chart and attributes P - nP - C and u charts - Industrial Examples - Process capability - Concept of six sigma - New seven Management tools

UNIT IV **9 Hours**

TQM TOOLS

Benchmarking - Quality Function Deployment (QFD) - House of Quality - QFD Process and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM) - FMEA - Stages of FMEA - Case studies

UNIT V **9 Hours**

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems - Elements - Implementation of Quality System - Documentation - Quality Auditing - ISO 9000:2015 - ISO 9001:2015 and ISO 9004:2018 - TS 16949 - ISO 14000 - ISO 50001 - Concept - Requirements and Benefits.

Total: 45 Hours

Reference(s)

1. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield, Mary Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management, Pearson Education, 5th Edition, 2018.
2. D.R. Kiran, Total Quality Management, Butterworth-Heinemann, 1st Edition, 2017.
3. Pankaj Lochan, Organizational Quality Management, TQM Deployment perspectives from manufacturing & process industry, TQM Publication Book 2, 2020.
4. Sayeda Begum, Chandrasekharan Rajendran, Prakash Sai L, K. Ganesh, Sanjay Mohapatra, Total Quality Management In Higher Education: Study Of Engineering Institutions, Routledge India, 1st Edition, 2020.
5. Sunil Luthra, A Dixit Garg, A Ashishgarwal, Sachin K Mangla, CRC Press, 1st Edition, 2020.
6. Poornima M Charantimath, Total Quality Management, Pearson Education, 4th edition, 2022.

22ME021/ 22MEM21 LEAN MANUFACTURING 3 0 0 3

Course Objectives

- To impart knowledge on globally competitive manufacturing organization using lean manufacturing principles
- To provide knowledge on various plant layout and techniques for improving the productivity
- To acquire knowledge on quality improvement tools such as TQM, 5S and VSM
- To expertise the six sigma tools applications in various industrial field
- To familiarize the methods of six sigma technique

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Assess conventional and lean manufacturing approaches, and explain the principles and key elements of lean manufacturing including foundational lean tools.
2. Design cellular layouts and implement Just-in-Time (JIT) and Kanban systems while applying the core principles and pillars of Total Productive Maintenance (TPM).
3. Apply techniques for setup time reduction, implement 5S methodology, and use Value Stream Mapping (VSM) and Total Quality Management (TQM) principles for process improvement.
4. Analyze quality issues using Six Sigma tools, including cost of quality analysis, quality control tools, seven management tools, and Failure Mode and Effect Analysis (FMEA).
5. Implement the DMAIC (Define, Measure, Analyze, Improve, Control) methodology and integrate Lean Six Sigma principles to improve manufacturing performance and quality.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	2	-	1
2	2	2	3	2	-	-	-	-	-	-	-	-	2	-	1
3	3	2	2	-	-	-	-	-	-	-	-	-	2	-	1
4	2	3	2	-	-	-	-	-	-	-	-	-	2	-	1
5	3	2	2	2	-	-	-	-	-	-	-	-	2	-	1

UNIT I **9 Hours**

INTRODUCTION TO LEAN MANUFACTURING

Conventional Manufacturing versus Lean Manufacturing, Principles of Lean Manufacturing, Basic elements of lean manufacturing, Introduction to LM Tools

UNIT II **9 Hours**

CELLULAR MANUFACTURING, JIT, TPM

Cellular Manufacturing, Types of Layout, Principles of Cell layout, Implementation, Just in Time (JIT), Principles of JIT and Implementation of Kanban, Pillars of Total Productive Maintenance (TPM), Principles and implementation of TPM

UNIT III **9 Hours**

SETUP TIME REDUCTION, TQM, 5S, VSM MANAGEMENT

Set up time reduction, Definition, philosophies and reduction approaches, Total Quality Maintenance Principles and implementation, 5S Principles and implementation, Value stream mapping, Procedure and principles

UNIT IV **9 Hours**

SIX SIGMA - TOOLS

Cost of Quality - Conformance and Non-conformance cost - Basic quality control tools - Seven management tools - Failure mode and effect analysis

UNIT V **9 Hours**

SIX SIGMA METHODOLOGY

Need for Six Sigma - Six Sigma Team - Define, Measure, Analyze, Improve and Control Methodology: Define Measure, Analyze, Improve and control - Lean Six Sigma

Total: 45 Hours

Reference(s)

1. Thomas Pyzdek, Paul A. Keller, The Six Sigma Handbook, 5th Edition, Tata Mc Graw Hill, 2021
2. Dr Gajendra Singh, KAIZEN - Continuous Improvement, 4th Edition, B Jain Publishers Pvt Ltd , 2020
3. Mary McShane-Vaughn, The ASQ Certified Six Sigma Black Belt Handbook, 4th Edition, American Society for Quality Press, 2022
4. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield, Mary Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management, Pearson Education, 5th Edition, 2018.
5. Frank Gryna, Richard Chua, Joseph Defeo, Quality Planning and Analysis For Enterprise Quality, 5th Edition, Tata Mc Graw Hill, 2017
6. Akhilesh B.. Singh, Producing Globally Competitive Steel - Lean Manufacturing and Digital Lean Transformation of Steel Industry , 1st Edition, White Falcon Publishing, 2022

22ME022 / 22MEM22 ENGINEERING ECONOMICS 3 0 0 3

Course Objectives

- Learn basics Engineering Economics, types of costs
- Impart different investment situations. economically sound decisions
- Study investment alternatives
- Learn market analysis to take optimal decisions
- Know the macro economics, taxes and inflation

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the principles of micro and macroeconomics to interpret economic systems, opportunity costs, organizational objectives, and production possibilities in a business context.
2. Analyze demand and supply functions by evaluating elasticity, demand forecasting methods, and consumer behavior models to support managerial decision-making.
3. Evaluate production and cost concepts, including returns to scale, cost–revenue analysis, and break-even models, to support effective resource allocation and operational efficiency.
4. Compare market structures and justify pricing methods, while applying capital budgeting techniques (NPV, IRR, ARR, Payback) to assess long-term investment decisions.
5. Interpret macroeconomic indicators such as national income, inflation, deflation, taxation, and fiscal/monetary policies to assess their impact on organizational financial accounting and decision-making.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	2	2	2	-	2
2	2	2	-	3	-	-	-	-	-	-	2	2	2	-	2
3	2	2	-	3	-	-	-	-	-	-	2	2	2	-	2
4	3	2	-	-	-	-	-	-	-	-	2	2	2	-	2
5	3	2	-	-	-	-	-	-	-	-	2	2	2	-	2

UNIT I **9 Hours**

INTRODUCTION

Introduction to Micro and Macroeconomics - Kinds of Economic Systems - Production Possibility Frontier - Opportunity Cost - Objective of Organizations - Kinds of Organization

UNIT II **9 Hours**

DEMAND AND SUPPLY

Functions of Demand and Supply - Law of diminishing Marginal Utility - Law of Demand and Supply - Elasticity of Demand - Demand Forecasting Methods - Indifference curve.

UNIT III **9 Hours**

PRODUCTION AND COST

Production Function - Returns to Scale - Law of Variable Proportion - Cost and Revenue concepts and Cost Curves - Revenue curves - Economies and Dis-economies of scale - Break Even point.

UNIT IV **9 Hours**

MARKET STRUCTURE

Market Structure - Perfect Competition - Monopoly - Monopolistic - Oligopoly - Components of Pricing - Methods of Pricing - Capital Budgeting IRR - ARR - NPV - Return on Investment - Payback Period.

UNIT V **9 Hours**

INTRODUCTION TO MACRO ECONOMICS AND FINANCIAL ACCOUNTING

National Income - Calculation Methods - Problems - Inflation - Deflation - Business Cycle - Taxes - Direct and Indirect Taxes - Fiscal and monetary policies.

Total: 45 Hours

Reference(s)

1. R. Kesavan, C. Elanchezhian, T. Sunder Selwyn, Engineering Economics and Financial Accounting, 1st Edition, Laxmi Publications, 2016.
2. V Mote, Samuel Paul, G. Gupta ,Managerial Economics Concepts and Cases, McGraw Hill Education, 1st Edition, New Delhi, 2017
3. K R Sharma, Corporate Financial Management, 1st Edition, Atlantic Publishers and Distributors (P) Ltd, 2023
4. S N Maheswari, Maheshwari Suneel K, Financial and Management Accounting, Sultan Chand and Sons, 1st Edition, 2022

22ME023 / 22MEM23 STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION — 3 0 0 3

Course Objectives

- To provide quality data from product measurements and process readings
- To study the usage of statistical approaches to regulate a process/ production method.
- To calculate both simple and multiple regression models.
- To introduce the basic principles and methods of statistical design of experiments.
- To qualify a new manufacturing process as being fit for use in production.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply statistical process control techniques to monitor and improve process quality by constructing and interpreting control charts, enabling real-time quality control and data-driven decision-making.
2. Assess the capability of manufacturing processes using appropriate statistical metrics and interpret process performance, for real-time analysis through relevant case studies.
3. Implement the regression analysis techniques including simple, multiple, and polynomial regression to model variable relationships, evaluate underlying assumptions, interpret ANOVA results, and assess model performance in real-world applications.
4. Design and analyze experiments using classical and Taguchi methods for single and multi-factor studies, interpret results statistically, and apply findings to real-world case studies for process optimization.
5. Develop response surface methodology to optimize processes using factorial, central composite, and Box-Behnken designs; analyze first-order response surfaces, and interpret results through case studies for process improvement.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
2	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
3	3	2	-	-	-	-	-	-	-	-	-	2	2	-	-
4	2	2	3	-	-	-	-	-	-	-	-	2	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	2	2	-	-

UNIT I **9 Hours**

STATISTICAL PROCESS CONTROL

Definition of quality and its evolution - Causes of variation in quality - Statistics and parameters - Variables and attributes - Frequency distribution - Histogram - Construction and interpretation - Use of software - Statistical basis of control chart - Anatomy of control charts - Selection and implementation of control charts - Control charts for variables and attributes - Simple case studies on applications of various types of control charts - Use of software.

UNIT II **9 Hours**

PROCESS CAPABILITY ANALYSIS

Process capability - Definition - Assumptions - Metrics - Methodology of process capability assessment - Case studies - Use of software.

UNIT III **9 Hours**

REGRESSION

Definition and need - Simple linear probabilistic model - Assumptions - Method of least squares - ANOVA for linear regression - Coefficient of determination - Multiple regression - General linear model and assumptions - ANOVA for multiple regression - Interpretation of results - Polynomial regression - Limitations of regression - Simple applications - Use of software.

UNIT IV **9 Hours**

EXPERIMENTAL DESIGN

Classical design of experiments - Single factor and multi-factor experiments - Analysis of experimental results - Taguchi design of experiments - Phases - Analysis and interpretation - Case studies - Use of software.

UNIT V **9 Hours**

RESPONSE SURFACE METHODOLOGY

Response surfaces - Two-level factorial designs - Addition of centre points - Method of steepest ascent - Central composite and Box-Behnken designs - Analysis of first order response surface - Case studies - Use of software.

Total: 45 Hours

Reference(s)

1. Grant E M and Leavenworth R L , "Statistical Quality Control", 7th Edition, Tata McGraw Hill, New Delhi, 2017
2. Douglas C. Montgomery , George C. Runger , "Probability and Statistics in Engineering", 6th Edition, Wiley, US, 2016
3. Myers R H, Montgomery D C and Anderson-Cook , "Response Surface Methodology, 4th edition, 2016
4. Process and Product Optimization using Designed Experiments", 4th Edition, Wiley, 2016.
5. Theodore T. Allen, " Introduction to Engineering Statistics and Lean Six Sigma: Statistical Quality Control and Design of Experiments and Systems", 2018

22ME024 OPERATIONS RESEARCH 3 0 0 3

Course Objectives

- To impart knowledge on the basics of linear programming techniques.
- To understand the transportation and assignment models.
- To provide knowledge on network models and project management.
- To learn the concept of queuing model and problems associated in it.
- To familiarize the sequencing and replacement models.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the principles of linear programming to formulate and solve engineering problems using graphical and simplex methods.
2. Analyze transportation and assignment problems to evaluate and compare allocation strategies using MODI and Hungarian methods.
3. Develop project networks for the given problems to determine critical paths and project durations using CPM and PERT techniques.
4. Investigate single and multi-server queuing models to interpret and assess system performance in service systems.
5. Develop sequencing strategies and replacement policies using analytical models to optimize industrial operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	2
2	2	3	-	-	-	-	-	-	-	-	-	2	2	-	2
3	2	2	3	-	-	-	-	-	-	-	-	2	2	-	2
4	2	2	2	3	-	-	-	-	-	-	-	2	2	-	2
5	2	2	3	-	-	-	-	-	-	-	-	2	2	-	2

UNIT I **9 Hours**

LINEAR PROGRAMMING

Operations Research - Introduction, Scope, Objectives, Phases, and its limitations. Linear Programming Problem(LPP) Formulation, Graphical method, Simplex method. Artificial variable techniques - Big-M method and two-phase method.

UNIT II **9 Hours**

TRANSPORTATION AND ASSIGNMENT MODEL

Transportation - Introduction, Initial basic feasible solutions - Northwest corner rule, Least cost method, and Vogel"s approximation method. Optimality test using MODI method. Assignment - Introduction and Hungarian method for optimal solution. Travelling salesman problem.

UNIT III **9 Hours**

NETWORK MODELS AND PROJECT MANAGEMENT

Network models - Introduction, Rules for construction and errors. Shortest route - Dijkstra"s algorithm, Minimal spanning tree - Kruskal"s algorithm, Maximum flow models. Project management - CPM and PERT networks.

UNIT IV **9 Hours**

QUEUING MODELS

Queuing model - Introduction , Elements, Kendall"s Notation, Parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.

UNIT V **9 Hours**

SEQUENCING AND REPLACEMENT MODEL

Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy.

Total: 45 Hours

Reference(s)

1. Frederick S. Hiller, Gerald J. Liberman, Introduction to Operations Research: Concepts and Cases, 8th edition, Tata McGraw-Hill Publishing Company Private Limited, 2010.
2. Hamdy A. Taha, Operation Research An Introduction, Pearson Publications, 2010.
3. Prem Kumar Gupta, D. S. Hira, Introduction to Operations Research, S.Chand and Co, 2004.
4. R. Panneerselvam, Operations Research, second edition, Prentice Hall of India, 2010.
5. K. Levy Ferdinand, D. Wiest Jerome, A Management Guide To PERT/CPM, With GERT /PDM/DCPM and Other Networks, 7th Edition, PHI Learning Private Limited, 2009.
6. Wagner, Operations Research, Prentice Hall of India, 2000.

22ME025 ENTERPRISE RESOURCE PLANNING 3 0 0 3

Course Objectives

- To enable the students to build up an integrated real-time view of core business processes.
- To understand the status of business commitments.
- To develop business management software - usually a suite of integrated applications.
- To create an integrated software system to manage the business and automate back office functions.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the concepts of MRP I, MRP II, and ERP to solve basic material and capacity planning problems and to explain the need and benefits of ERP across the product life cycle.
2. Analyze ERP implementation strategies, methodologies, and challenges to identify suitable solutions for system design, vendor selection, and cost management.
3. Design ERP-enabled business processes by integrating various functional modules such as production, HR, accounts, sales, and supply chain for enterprise-wide operations.
4. Formulate effective ERP implementation strategies by evaluating market trends, vendor capabilities, and the roles of consultants and users, addressing critical success and failure factors.
5. Integrate and evaluate ERP modules using real-world case studies in HR, finance, production planning, and materials management for organizational decision-making.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	2
2	3	2	-	-	-	-	-	-	-	-	-	2	2	-	2
3	2	2	3	-	-	-	-	-	-	-	-	2	2	-	2
4	3	2	-	-	-	-	-	-	-	-	-	2	2	-	2
5	2	2	-	3	-	-	-	-	-	-	2	2	2	-	2

UNIT I **9 Hours**

MRP AND INTRODUCTION TO ERP

Introduction - Overview of Material Requirement Planning (MRP I and MRP II) - Capacity requirements planning - History of ERP - Evolution of ERP - Comparison of ERP with traditional systems - Benefits of ERP - Need for ERP - Overview of modules in ERP- Product life cycle

UNIT II **9 Hours**

ERP IMPLEMENTATION

Traditional approach to information system design - New approach to system development - ERP implementation - Requirement analysis - Alternatives - Life cycle - Implementation methodology - Selection of an ERP package for suitability for manufacturing - Hidden costs - Case studies.

UNIT III **9 Hours**

BUSINESS MODULES IN ERP

Accounts - Production planning - Human resources - Plant maintenance - Materials management - Quality management - Sales and distribution - Ware house and supply chain - Case studies.

UNIT IV **9 Hours**

ERP MARKET

Implementation of ERP - Implementation life cycle - Phases - Transition strategies - ERP package selection - Implementation process - Role of vendors - Consultants and user in ERP implementation - Challenges to successful ERP implementation - Critical Success and failure factor - Operation and maintenance - Oracle - Peoplesoft - Lawson Software - Trends in ERP

UNIT V **9 Hours**

ERP CASE STUDIES

HRM - Finance and costing - Production planning - Materials management - Sales and distribution - Integration of modules.

Total: 45 Hours

Text Book(s)

1. Alexis Leon, "Enterprise Resource Planning", 4th Edition, Tata McGraw Hill, India, 2019.
2. Mary Sumner, "Enterprise Resource Planning", 1st Edition, Pearson Education, 2013

Reference(s)

1. Thorsten Ludtke, Marina Ludtke, "SAP BW/4HANA : The Comprehensive guide", 1st Edition, Rheinwerk Publications, 2021.
2. Jim Mazzullo, "SAP R/3 for Everyone", 1st Edition, Pearson, 2007
3. Ellen Monk , Bret Wagner Concepts in Enterprise Resource Planning, 4th edition, CENGAGE Learning Custom Publishing, 2012
4. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning-Concepts and Practice", PHI, 2011

22ME026 VALUE ANALYSIS AND VALUE ENGINEERING 3 0 0 3

Course Objectives

- To study the value engineering process and able to identify its functions within the process.
- To determine the appropriate value engineering methodology for a given project and propose appropriate training to centralized and decentralized modes.
- To learn various decision-making processes and cost evaluation models and apply them in appropriately in the product development life-cycle.
- To explore in-depth understanding of various value engineering applications in human resources, manufacturing and marketing.
- To demonstrate to implement value engineering solutions and propose to perfect them.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply value analysis principles to illustrate function-cost relationships in product design, measurable through a feature-function matrix project.
2. Analyze worth evaluation techniques to determine cost-worth relationships, demonstrated through case study.
3. Develop value engineering solutions using tools like brainstorming and morphological analysis, assessed.
4. Formulate specialized value engineering techniques like FAST and break-even analysis to optimize product design.
5. Implement a value engineering job plan to integrate cost-benefit analysis and recommendations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	-	-	-	-	-	-	2	2	2	-	2
2	2	2	-	3	-	-	-	-	-	-	2	2	2	-	2
3	2	2	3	-	-	-	-	-	-	-	2	2	2	-	2
4	2	2	2	3	-	-	-	-	-	-	2	2	2	-	2
5	3	2	2	2	-	-	-	-	-	-	2	2	3	-	2

UNIT I **9 Hours**

CONCEPTS OF VA AND VE

Meaning and purpose, historical background, status of VE in India, types of values; Function: Types, function identification on product, feature function matrix, function analysis; Cost: Elements of costs, calculation of costs, cost allocation to function, examples.

UNIT II **9 Hours**

WORTH ANALYSIS

Meaning and importance of worth, evaluation of worth, determining worth, guide lines to find worth, case studies; Team dynamics: Structure, team transformation, interpersonal relationship.

UNIT III **9 Hours**

GENERAL VE TOOLS

Brainstorming, Gordon technique, feasibility ranking, morphological analysis, ABC analysis, probabilistic approach, make or buy decision, case studies.

UNIT IV **9 Hours**

SPECIAL TECHNIQUES

Function cost, worth analysis, function analysis system techniques, technically oriented FAST, customer oriented FAST, weighted evaluation method, forced decision technique, quantitative method, predetermined minimum method, evaluation matrix, break even analysis, life cycle cost, case studies

UNIT V **9 Hours**

VE JOB PLAN

Orientation phase - ABC analysis, information phase - observation checklist, function phase - function cost worth analysis, creative and evaluation phase - evaluation of alternatives, cost benefit analysis, recommendation phase and implementation phase - recommendation plan, audit phase - operational audit, financial audit, applications of VE Job Plan Case studies

Total: 45 Hours

Reference(s)

1. Richard J Park, Value Engineering – A plan for invention, St.Lucie Press, London, 1998.
2. Kassa Abate O, Value Analysis and Engineering Reengineered, Taylor & Francis Inc, 2015.
3. Larry W Zimmesman. P E, Value Engineering-A Practical approach for owners designers and contractors, CBS Publishers, New Delhi,2019.
4. Del Younker, Value Engineering Analysis and Methodology", 1 St Edition, CRC Press, 2003.
5. Lawrence D. Miles, Techniques of Value Analysis and Engineering, Kindle Edition, 2015,
6. Mudge, Arthur E. Value Engineering- A systematic approach, McGraw Hill, New York, 2000.

22ME027 POWER PLANT ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on boilers and steam power plant.
- To learn about the various components associated with steam power plant.
- To study the working of nuclear and hydel power plant.
- To learn about the working of diesel and gas turbine power plant.
- To provide the knowledge on power plants using renewable energy and economics of power plants.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the principles of steam power generation to explain the layout, components, and working of boilers and thermal power plants
2. Assess the function and integration of auxiliary systems such as fuel handling, ash handling, draught systems, condensers, and cooling towers in steam power plants.
3. Select appropriate components and layout for nuclear and hydel power plants by analyzing reactor types, turbine selection, and governing methods.
4. Analyze the configuration and operational characteristics of diesel and gas turbine power plants under various load and cycle conditions.
5. Investigate renewable power generation systems and compute the economics of energy production considering fixed, operating costs and load sharing.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
2	2	-	1	-	-	-	-	-	-	-	-	-	-	1	2
3	2	1	2	-	-	1	-	-	-	-	-	-	-	1	-
4	2	1	1	-	-	-	-	-	-	-	-	-	-	1	2
5	2	3	2	-	1	2	2	-	-	-	-	-	1	1	-

UNIT I **9 Hours**

INTRODUCTION TO POWER PLANTS AND BOILERS

Layout of Steam power plant - Components, Selection. Steam Boilers and Cycles - High Pressure and Super Critical Boilers, Fluidized Bed Boilers. Combined Power Cycles. Comparison and Selection.

UNIT II **9 Hours**

STEAM POWER PLANT

Fuel and Ash Handling - Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, and Mechanical Collectors. Draught - different types. Surface Condenser types. Cooling Towers. Pollution controls.

UNIT III **9 Hours**

NUCLEAR AND HYDEL POWER PLANTS

Nuclear Energy - Fission, Fusion Reaction. Layout - Types of Reactors, Pressurized Water Reactor, Boiling Water Reactor, Waste Disposal and safety. Hydel Power Plant - Layout, Essential Elements, pumped storage. Selection of Turbines, Governing of Turbines.

UNIT IV **9 Hours**

DIESEL AND GAS TURBINE POWER PLANTS

Layout of Diesel power plant - Components, Selection of Engine Type, applications. Gas Turbine Power Plant - Layout, Fuels, Gas Turbine Material. Open and Closed Cycles - Reheating, Regeneration and Intercooling.

UNIT V **9 Hours**

OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS

Geo thermal power plant. Ocean thermal energy conversion (OTEC). Tidal power plant. Solar thermal power plant. Wind energy. Wind turbines. Magneto hydrodynamic generator (MHD). Cost of Electric Energy - Fixed and operating Costs, Economics of load sharing.

Total: 45 Hours

Reference(s)

1. S. C. Arora, S. Domkundwar, A course in Power Plant Engineering, Dhanpatrai & Sons, New Delhi, 2016.
2. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, New Delhi, 2019.
3. K.K.Ramalingam, Power Plant Engineering, Scitech Publications (India) Private Limited, 2015.
4. P. K. Nag, Power plant Engineering, Tata McGraw Hill Company Private Limited, New Delhi, 2017.
5. G. D. Rai, Introduction to Power Plant Technology, Khanna Publishers, New Delhi, 2013.
6. R. K. Rajput, Power Plant Engineering, Laxmi Publications, New Delhi, 2016.
7. https://archive.nptel.ac.in/courses/112/107/112107291/

22ME028 REFRIGERATION AND AIR CONDITIONING 3 0 0 3

Course Objectives

- To recall the basic principles, cycles and system in the Refrigeration system.
- To know the components of vapour compression various refrigeration systems and refrigerants
- To learn the operation of various refrigeration systems.
- To identify the parameters involved in design of air conditioning systems.
- To learn the procedure of installation, servicing and applications of Refrigeration and air-conditioning system.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the first and second laws of thermodynamics to evaluate the performance of refrigeration cycles and systems including reversed Carnot, Bell-Coleman, and vapour compression cycles.
2. Analyze the functional characteristics and performance of key refrigeration components (compressors, evaporators, condensers, and expansion valves) and determine the suitability of refrigerants based on environmental impact and system requirements.
3. Select the suitable refrigeration systems for specific applications by identifying the appropriate method of cooling, such as vapour compression, vapour absorption, thermo-electric, or cascade systems.
4. Formulate air conditioning solutions based on psychrometric analysis and cooling/heating load calculations for different environmental and building comfort conditions.
5. Develop and integrate installation, servicing, and safety protocols for various air conditioning systems, including industrial and automobile applications, based on user needs and operational constraints.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	2	-	2	2
2	2	3	-	-	-	-	-	-	-	-	-	-	-	2	2
3	2	2	2	-	-	-	-	-	-	-	-	2	-	2	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2	2
5	3	-	-	-	-	-	2	-	-	-	-	2	-	2	2

UNIT I **9 Hours**

BASIC PRINCIPLE, CYCLES AND SYSTEMS

First and Second law of thermodynamics applied to refrigerating machines - Reversed Carnot cycle, unit of refrigeration, co-efficient of performance. Air refrigeration: Bell-Coleman cycle, Types of air refrigeration systems. Need for modification of Carnot cycle, Ideal and actual vapour compression cycle, Improvements in simple vapour compression system.

UNIT II **9 Hours**

COMPONENTS OF REFRIGERATION SYSTEM

Types, and Working-Compressors, Evaporator, Condenser, Expansion Valve. Air conditioning systems and their types, selection of system, Components and controls of air distribution. Refrigerants - Types, Desirable properties and Nomenclature of refrigerants, Impact of refrigerants, recent substitutes for refrigerants.

UNIT III **9 Hours**

REFRIGERATION SYSTEM

General Layout, Working Principle- Vapour Compression Refrigeration system - Vapour absorption refrigeration system (Li-Br, Aqua Ammonia and solar) - Thermo-electric refrigeration system, Electrolux refrigeration system, Vortex refrigeration system, Steam jet refrigeration system and Cascade refrigeration system.

UNIT IV **9 Hours**

PSYCHROMETRIC AND AIR CONDITIONING SYSTEMS

Principle and properties of psychometric of air, Representation of various psychometric processes on psychometric chart and their analysis. Comfort Air Conditioning-parameters, requirements, concept of effective temperature, infiltration, internal heat gains, comfort charts. Window air conditioner, split air conditioner, Central air conditioner, Cooling and heating load calculations.

UNIT V **9 Hours**

INSTALLATION, SERVICING AND APPLICATIONS

Window AC and Split AC-installation Procedure, Charging methods, Leakage detection methods-Servicing and Safety Procedure. Importance, General layout, Working and limitations- Industrial Air conditioner-Food storage and preservation system-Ice manufacturing plant-Solar Air conditioner-Automobile air conditioner.

Total: 45 Hours

Reference(s)

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2017.
2. Langley and C. Billy, Refrigeration and Air conditioning, Ed. 3, Engle wood Cliffs (NJ), Prentice Hall of India, New Delhi, 2009
3. Roy J. Dossat, Principles of Refrigeration, Pearson Education, New Delhi, 2007
4. N. F Stoecker and Jones, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company, New Delhi, 2008
5. Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Limited, 2007
6. Dossat, R.J. Principles of Refrigeration system,Prentice Hall, 2013.
7. https://archive.nptel.ac.in/courses/112/105/112105129/

22ME029 ENERGY CONSERVATION AND MANAGEMENT 3 0 0 3

Course Objectives

- To understand different forms of energy and its conservation techniques.
- To identify the different types of energy audit and standards.
- To learn the energy efficiency enhancement methods in thermal utility systems.
- To know the energy efficiency enhancement methods in electrical utilities
- To assess the energy performance of different industry.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the principles of energy forms, sources, and conversion techniques to basic thermal, mechanical, and electrical systems including electricity tariffs.
2. Assess the scope and methodology of energy audits and energy management systems to implement efficiency measures and analyze cost-effective solutions.
3. Compare the performance of thermal utilities such as steam systems, boilers, and furnaces to identify energy losses and opportunities for conservation.
4. Analyze the efficiency of electrical systems including motors, compressors, and lighting to detect losses and propose improvement strategies.
5. Investigate energy generation and consumption patterns in thermal power stations, steel, cement, and textile industries to recommend performance improvement measures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	-	2	2
2	3	2	-	2	-	-	-	-	-	-	-	-	-	2	2
3	2	3	-	2	-	-	-	-	-	-	-	-	-	2	2
4	2	3	2	2	-	-	-	-	-	-	-	-	-	2	2
5	2	2	2	2	-	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

VARIOUS FORMS AND CONSERVATION OF ENERGY

Energy sources, classification: Electricity basics- DC, AC current, electricity tariff, Thermal Basics-thermal energy contents of fuel, Mechanical, electrical and thermal energy conversion techniques: energy conversion efficiencies.

UNIT II **9 Hours**

ENERGY MANAGEMENT

Scope, types of energy audit, energy audit methodology, role of energy managers; Energy management system (EnMS): ISO standards, implementing energy efficiency measures, detailed, project report, energy monitoring and targeting, economic and cost benefit analysis, energy service companies (ESCOS).

UNIT III **9 Hours**

ENERGY EFFICIENCY IN THERMAL UTILITIES

Steam engineering in thermal and cogeneration plants; efficient utilization of steam: Piping, traps, flashing, condensate recovery, pinch analysis; Boiler: Losses and efficiency calculation methods, controls; Furnaces: Heat balance and efficiency calculations, energy conservation opportunities, insulation and refractories

UNIT IV **9 Hours**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

Electrical system efficiency improvements: Motor, diesel generator, centrifugal pumps, fans, blowers, lighting systems; Air compressor: Line loss, leakage test, optimum pressure.

UNIT V **9 Hours**

PERFORMANCE ASSESSMENT

Industrial case studies: Assessment of energy generation/consumption in thermal station, steel industry, cement industry, textile industry.

Total: 45 Hours

Reference(s)

1. Alan P R, Beth P J , Energy Management and Efficiency for the Process Industries, Wiley Publications, 2015.
2. Abbi Y P, Shashank , "Handbook on Energy Audit and Environment Management.
3. The Energy and Resources Institute, 2009. Donald R Wulfinghoff, Energy Efficiency Manual, Energy Institute Press, 2011.
4. Bureau of Energy Efficiency, Energy Manager Training Manual, Government of India, 2015.
5. W. F. Kenny, Energy Conservation In Process Industry.
6. Amlan Chakrabarti, Energy Engineering and Management, Prentice hall India 2011.
7. https://archive.nptel.ac.in/courses/112/105/112105221/

22ME030 GAS DYNAMICS AND JET PROPULSION 3 0 0 3

Course Objectives

- To provide the knowledge on compressible flow.
- To analyse the isentropic flow through variable area ducts, Fanno flow and Rayleigh flow.
- To analyse the effect of flow properties on normal shock.
- To apply the basic gas dynamics theories for aircraft Propulsion systems.
- To learn the working of solid propellant and liquid propellant rocket engines.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply the principles of compressible flow and conservation equations to determine flow regimes, Mach number, and stagnation properties under varying flow conditions.
2. Analyze the effects of area variation in isentropic flow through ducts and interpret the influence of choking and Mach number on mass flow rate and impulse function.
3. Investigate the flow behavior and property variations in constant area ducts subjected to friction (Fanno flow) and heat addition (Rayleigh flow) using graphical and analytical methods.
4. Interpret the governing equations and flow property changes across normal shock waves, and assess shock implications in nozzles using the Prandtl and Rankine-Hugoniot relations.
5. Select appropriate propulsion systems and propellants based on performance criteria such as thrust, specific impulse, and application suitability.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2	2
2	2	3	-	-	-	-	-	-	-	-	-	-	-	2	2
3	2	2	2	2	-	-	-	-	-	-	-	-	-	2	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2	2
5	2	3	-	-	-	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

COMPRESSIBLE FLOW FUNDAMENTALS

Introduction to compressible flow - Integral and differential forms of conservation equations, velocity of sound, Mach number, various regimes of flow, wave propagation, Mach cone and Mach angle- Stagnation state - stagnation enthalpy, stagnation temperature, stagnation pressure and stagnation density - critical state - reference velocities, reference Mach number. Effect of Mach number on compressibility.

UNIT II **9 Hours**

FLOW THROUGH VARIABLE AREA DUCTS

Isentropic flow through variable area ducts - effect of area change on flow parameters, area ratio as a function of Mach number, impulse function, mass flow rate equations, chocking flow.

UNIT III **9 Hours**

FLOW THROUGH CONSTANT AREA DUCTS

Flow in constant area ducts with friction (Fanno flow) Governing equations, fanno curves and Fanno flow equations, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with simple stagnation temperature change (Rayleigh Flow) - Governing equations, Rayleigh line and Rayleigh flow equation, maximum heat transfer in Rayleigh flow.

UNIT IV **9 Hours**

FLOW WITH NORMAL SHOCK

Governing equations - variation of flow properties like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock - Prandtl equation - Rankine Hugonoit equation. Impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with normal shock.

UNIT V **9 Hours**

AIRCRAFT AND ROCKET PROPULSION

Aircraft propulsion - types of jet engines, energy flow through jet engines. Performance of turbo jet engines - thrust, thrust power, propulsive and overall efficiencies - thrust augmentation in turbo jet engine. Ram jet, Scram jet and Pulse jet engines. Rocket Propulsion - Classification of rocket engines. Propellants - solid, liquid and hybrid propellants, rocket engines thrust equation, effective jet velocity, specific impulse. Rocket engine performance.

Total: 45 Hours

Reference(s)

1. Patrick H. Oosthuizen and William E. Carscallen, Introduction to Compressible Fluid Flow, 2nd edition, CRC Press, Taylor & Francis Group, Florida, 2013.
2. Robert D. Zucker, Fundamentals of Gas Dynamics, 2nd edition, John Wiley & Sons Inc., New York, 2002.
3. H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen and P.V. Straznicky, Gas Turbine Theory, 7th edition, Pearson Education, 2017.
4. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, 9th edition, John Wiley & Sons Inc., New York, 2017.
5. S. M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th edition, New Age International private Limited, 2014.
6. https://archive.nptel.ac.in/courses/112/106/112106166/

22ME031 RENEWABLE ENERGY TECHNOLOGIES 3 0 0 3

Course Objectives

- To learn about solar radiation and solar thermal system application.
- To provide knowledge on fundamentals and sizing of solar photovoltaics.
- To study about the potential and energy conversion process of Wind Energy and Bio Energy.
- To impart fundamental knowledge about Ocean Thermal Energy and Geothermal Energy.
- To provide knowledge about the recent trends in Hydrogen and Fuel Cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply the principles of solar radiation and thermal conversion to examine various solar collectors and solar thermal applications including desalination, drying, and power generation.
2. Analyze the performance of solar photovoltaic systems by applying photovoltaic principles, and interpret I-V characteristics, module configurations, and maximum power point tracking techniques.
3. Illustrate the principles, technologies, and site selection criteria of wind and bio energy systems for efficient energy conversion and sustainable applications.
4. Investigate the working methodologies, resource potential, and technological devices of ocean energy and geothermal systems for effective energy harnessing.
5. Develop hydrogen-based energy systems and fuel cell technologies to support clean and sustainable energy applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	2	-	-	-	-	2	-	-	2
2	2	3	-	-	-	2	2	-	-	-	-	2	-	-	2
3	3	-	-	-	-	2	2	-	-	-	-	2	-	-	2
4	2	2	2	2	-	2	2	-	-	-	-	2	-	-	2
5	3	2	2	-	-	2	2	-	-	-	-	2	-	-	2

UNIT I **9 Hours**

SOLAR THERMAL SYSTEMS

Solar radiation, Radiation measurement, Introduction to solar collectors, Flat Plate collectors, evacuated tube collectors and concentrating collectors and Air heaters, Solar desalination systems, Solar drying systems, Solar thermal systems for power generation.

UNIT II **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEMS

Solar Photovoltaic systems: Basic Principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications.

UNIT III **9 Hours**

WIND ENERGY AND BIO ENERGY

Basic principles of wind energy conversion - classification of wind turbines, wind power generation curves, wind data and energy estimation. Site selection considerations. Bio mass resources, Energy from Bio mass, Biofuels classification, Biomass gasification- Technologies for utilisation of biomass, Biogas - Production, factors affecting biogas production, biogas plants, Bio mass Cogeneration.

UNIT IV **9 Hours**

OCEAN THERMAL ENERGY AND GEOTHERMAL ENERGY

Wave energy - Energy from waves, energy potential, conversion devices. Tidal energy - energy potential, conversion systems. Ocean thermal energy conversion systems. Geothermal energy - geothermal resources, geothermal conversion systems.

UNIT V **9 Hours**

HYDROGEN AND FUEL CELLS

Basic properties of hydrogen. Technologies of hydrogen production. Transformation of hydrogen energy - hydrogen economy. Fuel cells - operating principle, classifications, Specific characteristics, and applications.

Total: 45 Hours

Reference(s)

1. Bhatia, S. C., and Gupta, R. K., Textbook of Renewable Energy, India, Woodhead Publishing India PVT. Limited, 2018.
2. Twidell, John, and Weir, Anthony D., Renewable Energy Resources, United Kingdom, Taylor & Francis, 2006.
3. Nelson, Vaughn., Introduction to Renewable Energy, United Kingdom, CRC Press, 2011.
4. Cengel, Yunus A., Fundamentals and Applications of Renewable Energy, United States, McGraw Hill LLC, 2019.
5. Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017.
6. https://nptel.ac.in/courses/103103206

22ME032 COMPUTATIONAL FLUID DYNAMICS 3 0 0 3

Course Objectives

- To provide the knowledge on fundamental governing equations of fluid mechanics and heat transfer
- To acquire knowledge on formulation of governing Equations for fluid flow problems in finite difference method
- To study the steady and unsteady state diffusion type problems using finite volume method
- To impart one dimensional and two dimensional elements in finite element techniques for fluid flow problems
- To learn the structured and unstructured grids generation techniques and turbulence model

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply the fundamental equations of fluid dynamics, including the Navier–Stokes equations, and classify partial differential equations to establish a foundation for solving fluid flow problems.
2. Apply finite difference techniques to discretize and solve governing equations for fluid flow and analyze the stability, convergence, and accuracy of numerical methods for various flow regimes.
3. Analyze the finite volume method to discretize and solve one-dimensional and two-dimensional fluid flow problems, and analyze pressure-velocity coupling for steady-state flows.
4. Apply weighted residual and variational approaches of finite element method to solve steady-state heat conduction and incompressible flow problems in one-dimensional and two-dimensional domains.
5. Develop structured and unstructured computational grids using algebraic and differential grid generation techniques, and implement body-fitted coordinate methods to model complex geometries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	-	2	2
2	2	2	-	2	-	-	-	-	-	-	-	-	-	2	2
3	3	3	2	2	-	-	-	-	-	-	-	-	-	2	2
4	2	2	-	2	-	-	-	-	-	-	-	-	-	2	2
5	3	3	2	2	-	-	-	-	-	-	-	-	-	2	2

UNIT I **9 Hours**

INTRODUCTION TO CFD

Introduction - Applications and impact of CFD in diverse fields - Naiver Stroke equations in fluid dynamics-continuity-momentum and energy-generic integral form for governing equations -Initial and Boundary conditions. Classification of partial differential equations-Elliptic, Parabolic and Hyperbolic types.

UNIT II **9 Hours**

FINITE DIFFERENCE METHOD

Basics and discretization of simple and complex governing equations. Applications. Incompressible in-viscid Flows- Illustrative and physical examples of Elliptic, Parabolic and Hyperbolic equations - Discretization of partial Differential Equations. Implicit, explicit and Crank Nicolson finite difference methods for viscous flows. Stability, convergence, accuracy.

UNIT III **9 Hours**

FINITE VOLUME METHOD

Basic rules for FV Discretization. Finite Volume (FV) Discretization of one and two dimensional steady state diffusion type problems - 1-D convection-diffusion type problem - Unsteady flows - implementation of boundary conditions in Finite Volume. Solution of discretized equations. Solution algorithm for Pressure Velocity coupling in steady flows - Pressure-velocity coupling - SIMPLE scheme.

UNIT IV **9 Hours**

FINITE ELEMENT METHOD IN FLUIDS

Over view of Finite Element Techniques in Computational Fluid Dynamics. Weighted residual and Variational formulations. Finite element interpolation. One and two dimensional elements. Steady state conduction and incompressible potential flow problems.

UNIT V **9 Hours**

NUMERICAL GRID GENERATION AND TURBULENCE MODEL

Introduction. Algebraic grid generation. Differential Grid Generation. Structured and unstructured grids. Body fitted Coordinate Method. Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

Total: 45 Hours

Reference(s)

1. J. D. Anderson., Jr. Computational Fluid Dynamics- The Basic with Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
2. S. C. Gupta, Applied Computational Fluid Dynamics, Wiley India Pvt. Ltd., New Delhi, 2019.
3. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York, 2004.
4. H. K. Versteeg and W. Malalasakera, An Introduction to Computational Fluid Dynamics The Finite Volume Method, Pearson Education Ltd., New Delhi, 2007.
5. K. A. Hoffman, Computational Fluid Dynamics for Engineering, Engineering Education System, Austin, Texas 2005.
6. http://nptel.ac.in/courses/112105045/

22ME033 IC ENGINES AND EMISSIONS 3 0 0 3

Course Objectives

- To learn about the combustion phenomenon in spark ignition engines.
- To learn about the combustion phenomenon in compression ignition engines and cooling systems.
- To study the causes, effects and control of pollutants from an Internal Combustion engine.
- To provide the knowledge of alternate fuels in Internal Combustion engines.
- To impart the knowledge on recent developments in Internal Combustion engines.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the principles of combustion and mixture formation in spark ignition engines to analyze stages of combustion, knocking, and combustion chamber design.
2. Analyze the combustion process, fuel injection systems, and air motion characteristics in compression ignition engines to evaluate engine performance and knock control strategies.
3. Evaluate the suitability, benefits, and challenges of various alternative fuels and recommend necessary engine modifications for efficient operation.
4. Investigate the formation of pollutants in I.C. engines and assess emission control techniques through modern instrumentation and engine design alteration
5. Formulate advanced engine solutions using recent technologies like hybrid systems, lean burn, HCCI, variable valve timing, and camless valve systems for performance enhancement and emission reduction.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	2	-	2	2
2	2	3	-	-	-	-	2	-	-	-	-	2	-	2	2
3	2	2	-	-	-	-	3	-	-	-	-	2	-	2	2
4	2	2	2	2	-	-	3	-	-	-	-	2	-	2	2
5	3	-	-	-	-	-	3	-	-	-	-	2	-	2	2

UNIT I **9 Hours**

SPARK IGNITION ENGINES

Spark ignition engine- Mixture requirements, carburetors, fuel injection systems, mono point and multipoint injection, Combustion chambers: Simple thermodynamic analysis of SI engine combustion, Stages of combustion, normal and abnormal combustion, factors affecting knocking-combustion chambers.

UNIT II **9 Hours**

COMPRESSION IGNITION ENGINES.

States of combustion in Compression Ignition Engine - combustion knock in compression ignition engines, methods of controlling knock. Direct and indirect injection systems. Combustion chambers. Fuel sprays behavior-spray structure, spray penetration and evaporation. Lubricating and cooling systems; Air motion- Super and turbocharging. Performance of IC engines.

UNIT III **9 Hours**

ALTERNATIVE FUELS

Alternative fuels- CNG, alcohols, biodiesel, hydrogen, GTL, natural gas and liquefied petroleum gas, bio gas, properties, suitability, and demerits of fuels ,Engine modifications for alternate fuels (liquid and gaseous fuels), homogenous charge compression ignition engines.

UNIT IV **10 Hours**

POLLUTANT FORMATION AND EMISSION CONTROL.

Pollutant -formation of Oxides of Nitrogen in spark ignition and compression ignition engines, hydrocarbon emission - carbon monoxide formation - particulate emissions. Measurement of exhaust emissions- Non dispersive infrared gas analyser, gas chromatography, chemiluminescent analyser and flame ionization detector, smoke meters. Methods of controlling emissions- Catalytic converters and particulate traps. Exhaust gas recirculation and Selective catalytic Reduction. Additives for pollution control. Engine modifications to reduce emissions.

UNIT V **8 Hours**

RECENT TRENDS IN I.C ENGINES

Hybrid engines, Lean Burn Engines - stratified charge engines, homogeneous charge compression ignition, plasma Ignition. Variable valve timing, multi-valving, tuned manifolding, cam less valve gearing, Variable compression ratio engines.

Total: 45 Hours

Reference(s)

1. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Publishing Company Private limited., New Delhi,2015.
2. R. B. Mathur and R. P. Sharmal Internal Combustion Engines, Dhanpat Rai Publications, 2010.
3. B.P.Pundir, Internal combustion Engines Combustion and Emissions, Narosa Publishing House Private limited, New Delhi, 2017.
4. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Private limited., New Delhi, 2013.
5. W.W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 2006.
6. https://onlinecourses.nptel.ac.in/noc19_me10

22ME034 FUEL CELL VEHICLES 3 0 0 3

Course Objectives

- To outline the basics of fuel cells and the electrochemical reactions.
- To relate the principles, performance and applications of different fuel cells.
- To outline the fundamental concepts involved in fuel cell vehicles.
- To impart knowledge on the technologies associated with fuel cell powered vehicles
- To highlight the recent advancements in different fuel cell powered vehicles.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the principles of electrochemical energy conversion and fuel cell operation to evaluate performance parameters such as voltage, capacity, energy density, and efficiency.
2. Analyze the working principles, environmental impacts, and technical merits/demerits of various fuel cell types including PEMFC, PAFC, SOFC, and others.
3. Design a fuel cell-powered vehicle layout by integrating components such as fuel cell stacks, drive train, high-pressure hydrogen tanks, and power converters.
4. Evaluate the performance, operation modes, emission characteristics, and safety challenges of fuel cell vehicles compared to other propulsion technologies.
5. Formulate technological insights and performance comparisons of commercial fuel cell vehicles such as Toyota Mirai, Hyundai Nexo, and Mercedes Benz GLC based on real-world advancements.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	2	-	2	2
2	2	3	-	-	-	-	2	-	-	-	-	2	-	2	2
3	3	3	3	-	-	-	2	-	-	-	-	2	-	2	2
4	3	3	-	-	-	-	2	-	-	-	-	2	-	2	2
5	3	-	-	-	-	-	2	-	-	-	-	2	-	2	2

UNIT I **9 Hours**

BSICS OF FUEL CELLS

Operation of a cell - theoretical cell voltage - capacity - specific energy - energy density. Fuel cells - operating principle, specific characteristics, performance parameters, advantages. Difference between fuel cells, battery and solar cells. Applications in stationary and vehicle systems. Thermodynamics and electrochemical kinetics of fuel cells

UNIT II **9 Hours**

TYPES OF FUEL CELLS

Low, medium and high temperature fuel cells and reversible fuel cells. Principle of operation, environmental aspects, merits and demerits of Alkaline Fuel cells (AFC), Phosphoric Acid Fuel cells (PAFC), Polymer Electrolyte Membrane Fuel cells (PEMFC), direct methanol fuel cells, molten corbonate fuel cells, and Solid oxide fuel cells. Comparison of types of fuel cells

UNIT III **9 Hours**

INTRODUCTION OF FUEL CELL VEHICLE

Introduction to electric vehicle and hybrid vehicle. Fuel cell vehicle - Lay out, drive train, boost converter, propulsion units, high pressure tank and other components. Hydrogen as a fuel, onboard hydrogen storage, Fuel cells stack assembly.

UNIT IV **9 Hours**

FUEL CELL TECHNOLOGIES

Modes of operation, recuperative braking, refuelling, emission, air cleaning effect, safety aspects, challenges, plug in range, alternate power comparison. Configuration and control of DC Motor and induction Motor drives.

UNIT V **9 Hours**

ADVANCEMENTS IN FUEL CELL VEHICLES

Operating principles of Hydrogen Fuel cell vehicles, Toyota Mirai, Hyundai Nexo, Honda clarity, Audio A7 h-tron, Mercedes Benz GLC

Total: 45 Hours

Reference(s)

1. Shripad T. Revankar, Pradip Majumdar, Fuel Cells: Principles, Design, and Analysis, CRC Press, 2016.
2. Viswanathan B, Aulice Scibioh M, Fuel cells: Principles and Applications, University Press, 2009.
3. F. Barbir, PEM fuel cells: Theory and practice, Elsevier, Burlington, MA, Academic Press, 2013
4. M. Ehsani, Y. Gao and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2010.
5. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, Modern Electric, HybridElectric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2018.
6. Fuel cell Technology Handbook SAE International, Gregor Hoogers, CRC Press ISBN 0-8493-0877-1-2003.
7. https://archive.nptel.ac.in/courses/103/102/103102015/

22ME035 INSTRUMENTATION FOR THERMAL SYSTEMS 3 0 0 3

Course Objectives

- To classify various measuring instruments.
- To provide knowledge on temperature sensors and their applications in measurement.
- To impart knowledge on advancements in pressure and volume measurements.
- To learn about the various measurement techniques for thermos physical properties.
- To expose the knowledge on different data acquisition systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply knowledge of measurement principles to identify and analyze static and dynamic characteristics, errors, and reliability in instrument systems.
2. Analyze the performance and calibration methods of temperature sensors such as thermocouples, RTDs, and thermistors for accurate temperature measurement.
3. Evaluate suitable pressure and flow sensors, fittings, and calibration techniques for various fluids and industrial applications.
4. Investigate methods for determining thermo-physical properties such as thermal conductivity, specific heat, and viscosity using experimental techniques and modern tools.
5. Design basic SCADA-based data acquisition systems by selecting suitable hardware and communication technologies for industrial monitoring and automation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	-	2	2
2	2	3	-	-	-	-	-	-	-	-	-	2	-	2	2
3	2	3	-	-	-	-	-	-	-	-	-	2	-	2	2
4	2	2	2	2	-	-	-	-	-	-	-	2	-	2	2
5	2	2	2	-	-	-	-	-	-	-	-	2	-	2	2

UNIT I **9 Hours**

MEASUREMENT CHARACTERISTICS

Classification of instruments, Static and dynamic characteristics, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.

UNIT II **9 Hours**

TEMPERATURE MEASUREMENT

Temperature scale, Selection of Temperature sensors, Effect of length of sensor on temperature measurements, calibration of thermocouple, RTD and Thermistors, Standards for temperature measurement, Cryogenic and High Temperature measurement techniques.

UNIT III **9 Hours**

PRESSURE FLOW

Selection of Pressure Sensors, Piezoelectric transducers, Calibration of pressure sensors, Selection of pipes and fittings for pressure sensors. Selection of Volume sensors, Standard volumetric flask, Density measurement instruments for liquids and gases. Selection of Flow Sensors, Mass flow measurements for water, gases, other oils and chemicals.

UNIT IV **9 Hours**

MEASUREMENT OF THERMO PHYSICAL PROPERTIES

Thermal Conductivity measurement of solids, liquids and gases, Sensors and calibration methods, Thermal conductivity of microbar nano composites, Specific heat of liquids, solids through DSC analysis, viscosity measurement of Newtonian and non Newtonian fluids through rheological analysis.

UNIT V **9 Hours**

DATA ACQUISITION SYSTEM

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries, SCADA System Components, Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA/HMI Systems Various SCADA architectures.

Total: 45 Hours

Reference(s)

1. Bolton, William., Instrumentation and Control Systems, Netherlands, Elsevier Science, 2004.
2. Halit Eren, John G. Webster., Measurement, Instrumentation, and Sensors Handbook: Spatial, Mechanical, Thermal, and Radiation Measurement. United States, CRC Press, 2017.
3. Johnson, Curtis D., Process Control Instrumentation Technology, United Kingdom, Wiley, 1982.
4. Morris, Alan S., and Langari, Reza., Measurement and Instrumentation: Theory and Application, Netherlands, Elsevier Science, 2015.
5. Patranabi, D., Sensors and tranducers, India, PHI Learning, 2011.
6. Holman J.P., Experimental methods for Engineers, McGraw Hill, 2008.
7. https://archive.nptel.ac.in/courses/112/107/112107242/

22ME036 / 22MEH36 TOOL AND DIE DESIGN 3 0 0 3

Course Objectives

- To provide knowledge on design principles for designing the jigs and fixtures.
- To impart knowledge on locating and clamping principles for designing jigs and fixtures.
- To introduce the different types of jigs for producing the part.
- To study different types of fixtures for the producing the part.
- To introduce about press working terminologies and press accessories.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply principles of tool design for jigs and fixtures, by following limits, fits, and geometric tolerances to ensure precision in manufacturing tools
2. Demonstrate location and clamping principles to design effective jigs and fixtures using various clamping methods for improved manufacturing accuracy and efficiency
3. Design jigs by selecting appropriate elements, drill bushes, and mechanisms to meet production and operational requirements for specified components
4. Develop fixture designs for machining and inspection processes by integrating general principles and selecting suitable types for specific component operations
5. Analyze and design press tools including dies, punches, and press accessories for bending, forming, and drawing operations, considering factors like spring-back and tonnage calculations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-
5	2	3	2	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION TO TOOL DESIGN

Objectives, Challenges and Requirements, Production and Inspection Devices. Jigs and Fixtures - Differences, Design principles, Advantages, Essential Features, Materials used. Introduction to Limits, Fits and Tolerances, International Tolerance Grades, Geometric Dimensioning and Telebanking in tools.

UNIT II **9 Hours**

LOCATION AND CLAMPING

Location - Principles, Basic rules, Degrees of Freedom, 3-2-1 Principle, Locating Methods, Types of Locators, Standard Parts. Clamping - Principles, Types of Mechanical Actuation Clamps, Pneumatic, Hydraulic, Magnetic, Vacuum, Electrostatic clamping, Epoxy Resin Clamping. Factors considered for Design of Jigs and Fixtures.

UNIT III **9 Hours**

DESIGN OF JIGS

Jigs - Elements, Construction, Types and Materials for Jig Elements. Drill bushes - Types, Special Bushes, Bush Clearance. Automatic drill jig, Rack and pinion operated, Indexing, Air operated Jig components - Design of Jigs for given components.

UNIT IV **9 Hours**

DESIGN OF FIXTURES

General Design Principles of Fixture. Types of Boring, Lathe, Milling and Broaching fixtures - Setting Block. Grinding, Planing and Shaping fixtures. Inspection - Gauging, Measuring and Supplement fixtures. Welding, Assembly and Modular fixtures. Design of fixtures for given component.

UNIT V **9 Hours**

DESIGN OF PRESS TOOLS

Mechanical Presses - Working terminology, Elements, Types and Press Accessories. Types of Dies, Punches and Strippers. Pressure pad, Knockouts, Stops and Pilots. Bending, Forming, Drawing and Deep Drawing - Dies and its Types. Spring-back phenomenon and Draw Ratio. Progressive, Combination and Compound Dies. Design and Development of Dies - Blank Development, Strip Layout, Computation of capacities and tonnage requirements.

Total: 45 Hours

Reference(s)

1. Edward G. Hoffman, Jig and Fixture Design, Cengage Learning, New Delhi, 2004
2. C. Elanchezhian, Design of Jigs, Fixtures and Press Tools, Eswar Press, Chennai, 2010
3. P. H. Joshi, Jigs & Fixtures, Tata McGraw Hill Education Private Limited, New Delhi 2012
4. Hiram E Grant, Jigs and Fixtures, Tata McGraw Hill Education Private Limited, New Delhi, 2011
5. C. Donaldson, G. H. Lecain and V. C. Goold, Tool Design, Tata McGraw Hill Education Private Limited, New Delhi, 2011
6. Fred Herbert Colvin, Lucian Levant Hass, Jigs and Fixtures: A Reference Book Showing Many Types of Jigs and Fixtures in Actual Use, and Suggestions for Various Cases, Nabu Press, 2011

22ME037 / 22MEH37 GEOMETRIC MODELLING 3 0 0 3

Course Objectives

- To provide the knowledge on coordinate systems.
- To study the mathematical modelling of analytical and synthetic curves.
- To learn the parametric and non- parametric forms of analytical and synthetic surfaces.
- To impart the knowledge about solid modelling techniques.
- To learn the transformation and projection techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the principles of geometric and display coordinate systems to support 3D modelling and visualization.
2. Formulate analytical and synthetic curve models using parametric and non-parametric representations to understand curve generation and modification in geometric modelling.
3. Develop analytical and synthetic surface models using parametric and non-parametric forms to understand surface generation and transformation techniques in geometric modelling.
4. Analyze the solid modelling techniques to create and manipulate solid models with defined geometric properties.
5. Demonstrate the 2D and 3D transformation and projection techniques to visualize geometric models through orthographic and perspective projections.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	1	-	1	-	-	-	-	2	-	-
2	3	2	2	-	-	1	-	1	-	-	-	-	2	-	-
3	3	2	2	-	-	1	-	1	-	-	-	-	2	-	-
4	3	2	-	-	-	1	-	1	-	-	-	-	2	-	-
5	3	-	-	-	-	1	-	1	-	-	-	-	2	-	-

UNIT I **9 Hours**

COORDINATE SYSTEMS

Geometric co-ordinate systems - Cartesian, Cylindrical and Spherical coordinate systems. Display co-ordinate systems - Global, Local, View and Screen coordinate systems.

UNIT II **9 Hours**

MATHEMATICAL MODELLING OF CURVES

Definition - Parametric and non-parametric forms of analytical and synthetic curves. Analytical Curve modelling - Line Segment, Circle, Ellipse. Synthetic Curve modelling - Hermite Cubic Spline, Bezier, B-spline and Rational Curves. Curve manipulation techniques.

UNIT III **9 Hours**

MATHEMATICAL MODELLING OF SURFACES

Definition - Parametric and non- parametric forms of analytical and synthetic surfaces. Analytical surface modelling - Parametric form of plane, loft, Cylindrical, Surface of revolution. Synthetic Surface modelling - Hermite Bicubic Spline, Bezier, B-spline, Coon"s, triangular, blending Surfaces. Surface Manipulation techniques.

UNIT IV **9 Hours**

MATHEMATICAL MODELLING OF SOLIDS

Properties of solid model, solid modelling Techniques - Boundary representation, Constructive Solid Geometry, Analytical Solid Modelling, Sweep representation schemes. Solid Manipulation Techniques.

UNIT V **9 Hours**

TRANSFORMATION AND PROJECTION TECHNIQUES

Introduction to computer graphics, Non-interactive Vs interactive computer graphics, applications, graphics system configuration. 2D and 3D transformation techniques - Translation, Rotation, Scaling and Reflection principles. Principle of concatenated transformation. Orthographic and Perspective Projections of Geometric Models.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Education (P) Ltd., Special Indian Edition, 2014.
2. Amarendra N Sinha and Arun D Udai, Computer Graphics, Second reprint, Tata McGraw Hill Education (P) Ltd., 2014.
3. Michael E. Mortenson, Geometric Modeling, Third edition, Industrial Press, 2006.
4. Rogers, Mathematical Elements for computer Graphics, Tata Mcgraw Hill Education Private Limited, 2009.
5. Rajiv Chopra, Computer Graphics: A Practical Approach, Concepts, Principles, Case Studies, First Edition, S-Chand and Company Ltd., 2011.

22ME038 / 22MEH38 ERGONOMICS 3 0 0 3

Course Objectives

- To learn the importance of ergonomics approach in product design and development.
- To study the human information input and workstations to fit employees
- To develop appropriate control measures for ergonomics risk factors
- To explore the workplace according to good ergonomics principles
- To assess ergonomics aspects of the working environment and work organisation

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Analyze the human-machine systems, system reliability, and the stages of conceptual to detailed design in manual, mechanical, and automated environments to explain the multidisciplinary approach to human factors engineering.
2. Investigate various modes of information input and processing, including text, graphics, symbols, codes, and multi-sensory displays to optimize human-system interaction.
3. Assess human physical output and control mechanisms to enhance system performance and user safety.
4. Apply ergonomic principles and anthropometric data to design workspaces, seating, component layout, and manual tasks that reduce fatigue, enhance work capacity, and improve comfort and interpersonal efficiency in the workplace.
5. Integrate the impact of environmental conditions and human factors on performance, safety, and system design by analyzing variables in accordance with ISO/DIS 6385 and OSHA guidelines.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	1	-	1	-	-	-	-	2	-	-
2	3	2	-	-	-	1	-	1	-	-	-	-	2	-	-
3	3	2	-	-	-	1	-	1	-	-	-	-	2	-	-
4	3	-	-	-	-	1	-	1	-	-	-	-	2	-	-
5	3	2	1	-	-	1	-	1	-	-	-	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION TO HUMAN FACTORS ENGINEERING

Definition - human technological system - multidisciplinary engineering approach - human - machine system - manual - mechanical - automated system - human system reliability conceptual design - advanced development - detailed design and development

UNIT II **9 Hours**

INFORMATION INPUT

Input and processing - text - graphics - symbols - codes - visual display of dynamic information - auditory - tactual - olfactory displays - speech communications.

UNIT III **9 Hours**

HUMAN OUTPUT AND CONTROL

Physical work - manual material handling - motor skill - human control of systems - controls and data entry devices - hand tools and devices.

UNIT IV **9 Hours**

WORKPLACE DESIGN

Applied anthropometry - workspace design and seating - arrangement of components within a physical space - interpersonal aspects of work place design - design of repetitive task - design of manual handling task - work capacity - stress - and fatigue.

UNIT V **9 Hours**

ENVIRONMENTAL CONDITIONS AND HUMAN FACTORS APPLICATIONS

Illumination - climate - noise - motion - sound - vibration - colour and aesthetic concepts. Human error - accidents - human factors and the automobile - organizational and social aspects - steps according to ISO/DIS6385 - OSHA""s approach - virtual environments.

Total: 45 Hours

Reference(s)

1. Chandler Allen Phillips, "Human Factors Engineering", John Wiley and Sons, 2000
2. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, 1993.
3. Bridger R S , "Introduction to Ergonomics", Taylor and Francis, 2003.
4. Mayall W H , "Industrial Design for Engineers", London ILIFFE Books Ltd., 1998.
5. Martin Helander , "A Guide to Human Factors and Ergonomics", 2nd Edition, CRC Press, 2005.
6. Mark Lehto, Steven J. Landry , "Introduction to Human Factors and Ergonomics for Engineers", 2nd Edition, CRC Press, 2012.

22ME039 / 22MEH39 PRODUCT DATA AND LIFE CYCLE MANAGEMENT **3 0 0 3**

Course Objectives

- To understand the exposure on the internet based technology for the implementation of product life cycle concepts in product development.
- To familiarize the concepts, functions and administration features of Product Data Management.
- To educate the features of product life cycle management involved to resolve the problems while automating product dependent business processes
- To provide exposure on implementation of visualization and virtual reality approach and its techniques in product development
- To explore the diverse ways of integrating PLM with other CAD & ERP software for product development

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Implement Product Life Cycle Management concepts in development of products with the help of Internet
2. Demonstrate the data management of specific project / process in an industry
3. Apply the product life cycle management in product depended business automation
4. Create the virtual reality model of product development using unique technique
5. Analyze the results of integrating PLM with CAD & ERP in product development

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	3	2	2	-	-	-	2	-	-	2	-	1
2	2	1	2	3	2	2	-	-	-	2	-	-	2	-	1
3	1	1	2	2	2	2	-	-	-	3	-	-	2	-	1
4	2	2	2	1	2	2	-	-	-	2	-	-	2	-	1
5	1	1	3	2	3	-	-	-	-	2	-	-	2	-	1

UNIT I **9 Hours**

PRODUCT DEVELOPMENT AND PRODUCT LIFECYCLE

Product development process and functions, present market constraints, need for collaboration, collaborative product development, use of internet class technologies and data transfer, various developments on internet technology that support product development and its impact on business. Concept of product lifecycle different phases of product lifecycle and corresponding technologies, its uses and examples

UNIT II **9 Hours**

PRODUCT DATA MANAGEMENT (PDM)

PDM functions, PDM system and importance, architecture of PDM systems, document management, representation of lifecycle of business objects, concepts on roles, users and project management, system administration, access control and its use in lifecycle.

UNIT III **10 Hours**

AUTOMATING BUSINESS PROCESSES

Product Lifecycle Management (PLM) architecture, components of PLM, lifecycle problems to resolve, Workflows, lifecycle and work flow integration, product configuration, bill of materials management, product structure, configuration management and engineering change management. Introduction to Product Manufacturing Information (PMI) and Model Based Definition (MBD

UNIT IV **9 Hours**

PRODUCT VISUALISATION

Use of CAD neutral approach and visualization techniques in product development, capabilities of PLM visualization software ,light weight representations, markup method, representation information repository, use of visualization in different stages of lifecycle, case studies. Introduction to virtual reality, digital mock-up, virtual testing and validation

UNIT V **8 Hours**

INTEGRATION OF PLM WITH OTHER SYSTEMS

Benefits of integrating PLM system with other systems, different ways to integrate PLM systems with other systems, integration with CAD and ERP - use of middleware in integrating business applications in product development. PLM software customisation.

Total: 45 Hours

Reference(s)

1. Michael Grieves, "Product Lifecycle Management", Tata McGraw Hill, 2006
2. Faisal Hogue, "E-Enterprise Business Models Architecture and Components", Cambridge University Press, 2000
3. Alexis Leon, "Enterprise Resource Planning", Tata McGraw Hill, 2002
4. Danier Amor, "The E-Business Revolution", Pearson Education Asia, 2000.
5. David Ferry, Larry Whipple, "Building an Intelligent e-Business", Prima Publishing, 2000
6. David Bedworth, Mark Hederson, Phillip Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill Inc 1991.

22ME040 / 22MEH40 PRODUCT DEVELOPMENT AND REVERSE ENGINEERING

3 0 0 3

Course Objectives

- To develop a new product by practicing a typical NPD Process followed in Industry
- To learn value engineering and product design tools to design a product
- To perform the Engineering Change Management process for a product
- To familiarize with the concept and design guidelines for manufacturing parts by different machining processes
- To educate the emerging trends and applications of reverse engineering and Additive manufacturing technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Illustrate the product development cycle and evaluate strategies such as idea screening, concept testing, and commercialization using product life cycle management tools.
2. Apply value engineering techniques and product design tools like QFD, DFA, DFM, and ergonomic principles to improve design efficiency and cost-effectiveness.
3. Participate in the Engineering Change Management process and analyze the roles, impacts, and documentation (ECR, ECN, ECO) in product data workflows.
4. Apply DFMA and DFE guidelines to design sustainable, recyclable, and regulation-compliant products considering various manufacturing processes.
5. Utilize reverse engineering tools (CMM, laser scanner, CT, MRI) and STL software for point cloud processing and demonstrate applications of additive manufacturing across industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	-	-	-	-	2	2	-
2	3	3	3	-	3	-	-	-	-	-	-	-	3	3	-
3	2	3	-	2	2	-	-	-	-	-	-	-	2	3	-
4	2	2	3	-	3	-	3	-	-	-	-	-	3	3	-
5	3	2	3	2	3	-	-	-	-	-	-	-	3	3	-

UNIT I **9 Hours**

INTRODUCTION TO NEW PRODUCT DEVELOPMENT

Product life cycle, Product policy of an organization. Selection of a profitable product, Product design process, new product strategy Idea generation and screening Concept development and testing Business analysis Product development testing and analysis Commercialization Collaboration Gantt chart product life cycle management.

UNIT II **9 Hours**

VALUE ENGINEERING AND PRODUCT DESIGN TOOLS

Value engineering in product design, Advantages, Applications in product design. Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design.

UNIT III **9 Hours**

ENGINEERING CHANGE MANAGEMENT

Product Data Management, Engineering Change Management Process Impact of ECM, Typical steps followed, Different roles in an ECM Process, Participating in an ECM process, Engineering Change Request, Engineering Change Notice, Engineering Change Orders.

UNIT IV **9 Hours**

DFMA GUIDELINES

Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc. Design for Environment (DFE) methods, Design guide lines, Lifecycle assessment, Design to minimize material usage, Design for disassembly, Recyclability, Remanufacture, Energy efficiency, Design to regulations and standards.

UNIT V **9 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering, Application of CMM, Laser scanner, CT and MRI scan in acquiring point data, Software for STL file processing. Application of Rapid prototyping in medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP Systems.

Total: 45 Hours

Reference(s)

1. T. Karl, Ulrich and D. Steven, and Eppinger, Product Design and Development, Mcgraw Hill 2009
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973.
3. Robert Matousek, Engineering Design A Systematic Approach, Blackie and Son Limited, London, 1974.
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.
6. https://nptel.ac.in/courses/112107217/

22ME041 DESIGN FOR MANUFACTURING AND ASSEMBLY 3 0 0 3

Course Objectives

- To learn the way of specifying geometric dimensioning and tolerancing in engineering drawing
- To familiarize the design considerations for designing components for the casting, welding and forming processes
- To familiarize the design guidelines while designing components which are manufacturing by different machining processes
- To learn the factors affecting easy assembly of parts into a final product
- To impart knowledge about the product life cycle assessments and environmental impact of materials, manufacturing methods and the way to minimize it

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Analyze geometric dimensioning and tolerance features to determine their influence on functional dimensions and overall assembly precision.
2. Design cast, welded, and formed components by applying manufacturing design principles to minimize defects and ensure production feasibility.
3. Implement design for manufacture and assembly (DFM & DFA) strategies to enhance machining efficiency and assembly effectiveness.
4. Apply design for assembly (DFA) principles to reduce part count and handling time, thereby increasing assembly efficiency.
5. Formulate eco-friendly design strategies by incorporating lifecycle assessment and sustainability practices in product development.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	-	-	2	-	-	-	-	-	-	2	2	-	1
2	3	2	3	2	2	-	-	-	-	-	-	2	2	-	1
3	3	-	3	2	2	-	-	-	-	-	-	2	2	-	1
4	3	-	3	2	2	-	-	-	-	-	-	2	2	-	1
5	3	2	2	2	2	-	-	-	-	-	-	2	2	-	1

UNIT I **10 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. Geometric Dimensioning and Tolerancing - Location, Form, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, parting line - Redesign of castings based on parting line considerations, Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components

UNIT III **8 Hours**

DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for Manufacture Guidelines - Design features to facilitate machining - Drills - Milling cutters -Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area Simplification by separation - Simplification by amalgamation. Design for Manufacture: Machinability, Economy, Clamp ability, Accessibility, Assembly. Redesign for Manufacture -Examples.

UNIT IV **8 Hours**

DESIGN FOR ASSEMBLY

Design for Assembly (DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours**

DESIGN FOR ENVIRONMENT

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&T"s (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards.

Total: 45 Hours

Reference(s)

1. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design,McGraw-Hill Professional, New Delhi, 2011
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973
3. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 1974
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw-Hill Publications, New Delhi, 2000
6. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.

22ME042 DATABASE MANAGEMENT SYSTEMS 3 0 0 3

Course Objectives

- To provide knowledge on the database architecture and purpose of database system.
- To understand the data models, conceptualize and depict a database system.
- To gain knowledge on the normal forms with functional dependencies.
- To impart knowledge on data storage and query processing.
- To learn transaction management and time stamp-based protocols.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Differentiate database systems from file system by understanding the features of database system and design a ER model for a database system.
2. Develop solutions to a broad range of query and data update problems using relational algebra, relational calculus and SQL.
3. Apply the normalization theory in relational databases for removing anomalies.
4. Compare database storage and access techniques for file organization, indexing methods and Query Processing.
5. Analyze the basic issues of transaction processing, concurrency control, deadlock and its recovery schemes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
2	1	2	3	-	2	-	-	-	-	-	-	-	3	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
5	1	3	2	-	-	-	-	-	-	-	-	-	1	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction: Database system application, purpose of database system View of Data -Database Languages-Data Storage and Querying-Database Architecture - Database design and ER model: Overview of the design process-The ER Model - Constraints - ER Design Issues.

UNIT II **9 Hours**

RELATIONAL MODEL AND DATABASE DESIGN

Introduction to Relational Model - Formal Relational Query Languages - Introduction to SQL: Data definition-Basic structure of SQL Queries-Additional Basic operations -Set Operations-Aggregate functions Nested sub queries-Intermediate SQL: Joins.

UNIT III **9 Hours**

NORMAL FORMS

Functional Dependencies - Normal Forms Based on primary Keys-General Definition of Second and Third Normal Form - Boyce Codd Normal Form - Multi valued dependencies and Fourth Normal Form.

UNIT IV **9 Hours**

DATA STORAGE AND QUERY PROCESSING

Overview of Physical Storage Media - Magnetic disk Flash storage -RAID-File and Record Organization - Query Processing: Overview-measures of Query Cost.

UNIT V **9 Hours**

TRANSACTION MANAGEMENT

Transactions: Transaction concept-Transaction Atomicity and Durability-Transaction Isolation-Serializability-Transaction Isolation and Atomicity-Transaction Isolation levels-Implementation of Isolation Levels-Concurrency Control: Lock based protocols -Time stamp based protocols.

Total: 45 Hours

Reference(s)

1. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, Database System Concepts , McGraw - Hill, 2015.
2. Ramez Elmasri and Shamkant B. Navathe, Fundamental Database Systems,Pearson Education,2008.
3. Raghu Ramakrishnan, Database Management System, Tata McGraw-Hill Publishing Company,2003.
4. C.J.Date,An Introduction to Database system, Pearson Education, 2006.
5. Peter Rob and Corlos Coronel, Database System, Design, Implementation and Management ,Thompson Learning Course Technology, 2004.

22ME043 MECHATRONICS SYSTEM 3 0 0 3

Course Objectives

- To understand the mechatronics design process.
- To study the data acquisition and control case studies.
- To summarize the application of mechatronics system.
- To explain the real-time system in real-time interfacing
- To explore the problems in mechatronics system.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the principles of mechatronics design to distinguish between traditional and advanced design approaches considering ergonomics and safety.
2. Develop system models across mechanical, electrical, and control domains, and validate them for real-world mechatronic applications.
3. Implement real-time data acquisition and interfacing using I/O systems and software platforms like LabVIEW and Vim-Sim for effective control.
4. Analyze practical mechatronic systems through case studies involving motion control, sensing, image processing, and intelligent automation.
5. Evaluate the design principles, scaling laws, and application potential of micro mechatronic systems including micro-actuators and micro-robots.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
5	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION TO MECHATRONICS SYSTEM

Key elements - Mechatronics Design process -Design Parameters - Traditional and Mechatronics designs - Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.

UNIT II **9 Hours**

SYSTEM MODELLING

Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation domain-independent description forms-simulator coupling.

UNIT III **9 Hours**

REAL TIME INTERFACING

Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process, Application Software- LabVIEW Environment and its applications, Vim-Sim Environment & its applications -Man machine interface.

UNIT IV **9 Hours**

CASE STUDIES ON MECHATRONIC SYSTEM

Introduction -Fuzzy based Washing machine - pH control system - Autofocus Camera, exposure control - Motion control using D. C. Motor & Solenoids - CNC related -Engine management systems - Controlling temperature of a hot/cold reservoir using PID- Control of pick and place robot - Part identification and tracking using RFID - Online surface measurement using image processing.

UNIT V **9 Hours**

MICRO MECHATRONIC SYSTEM

Introduction- System principle - Component design - System design - Scaling laws - Micro actuation - Micro robot - Micro pump - Applications of micro mechatronic components.

Total: 45 Hours

Reference(s)

1. Bishop, Robert H, Mechatronics Hand book, CRC Press, 2002.
2. Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, CRC Press 1991 , First Indian print 2010.
3. De Silva, Mechatronics: A Foundation Course, Taylor & Francis, Indian Reprint, 2013.
4. Devdas shetty, Richard A. Kolk, Mechatronics System Design, 2nd Edition ,Cengage Learning 2011.
5. Georg pelz, Mechatronic Systems: Modeling and simulation with HDLs, John wiley and sons Ltd, 2003

22ME044 INDUSTRIAL AUTOMATION 3 0 0 3

Course Objectives

- To understand the need of automation in various industrial sectors
- To understand different types of PLC programming techniques.
- To understand SCADA systems are used to collect and monitor data from industrial processes.
- To apply DCS system to control a large-scale industrial process.
- To analyze the security of a communication system against potential threats

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply appropriate automation technologies for specific industrial sectors by examining and selecting the optimal system.
2. Develop PLC programs using various programming techniques, including programming languages and logical instructions.
3. Configure a SCADA system to monitor and control industrial processes, demonstrating the ability to implement its functionalities and tools effectively.
4. Analyze the security of a Distributed Control System (DCS) against potential threats, identifying vulnerabilities and areas of improvement.
5. Evaluate the effectiveness of security measures in safeguarding communication systems, assessing their capability to protect against potential cyber threats.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	-	2	1	-	-	-	-	-	-	1	-	-
2	3	1	1	-	2	1	-	-	-	-	-	-	3	-	-
3	3	1	1	-	2	1	-	-	-	-	-	-	3	-	-
4	3	2	2	-	2	1	-	-	-	-	-	-	3	-	-
5	3	1	1	-	2	1	-	-	-	-	-	-	3	-	-

UNIT I **9 Hours**

BASICS OF AUTOMATION

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines, Fundamentals of IoT

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming Languages- Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT III **9 Hours**

SUPERVISORY CONTROL AND DATA ACQUISITION

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode functions-Tools: Tag Database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT IV **9 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses -Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

Total: 45 Hours

Reference(s)

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2016
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009
5. Lucas M.P, Distributed control systems, Van Nostrand Reinhold Company, Newyork, 1986

22ME045 MODELLING OF INDUSTRIAL ROBOTS 3 0 0 3

Course Objectives

- To understand the different types of end-effector mechanisms and their respective functionalities in robotic systems.
- To understand kinematics, dynamics and programming of robot mechanisms
- To apply trajectory generation, motion analysis of robotic movements and robot vision
- Explain the principles of Lagrangian mechanics and the effects of moments of inertia in robot dynamics.
- Apply the kinematics of wheeled mobile robots and the predictive modeling and system identification techniques used in mobile robotics.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO1: Implement new ideas on product/process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Differentiate between types of robot manipulators, classify robot configurations, and analyze end-effector mechanisms for selecting suitable robots in industrial applications.
2. Apply kinematic principles such as coordinate transformations, Euler angles, and Denavit–Hartenberg convention to demonstrate forward and inverse kinematics of robotic manipulators.
3. Analyze velocity and static force relationships of robotic manipulators using Jacobians, and evaluate singularities to determine manipulator workspace limitations.
4. Develop and compute dynamic equations of robotic systems using Lagrangian mechanics, and plan suitable point-to-point and continuous trajectory paths for motion control.
5. Investigate mobile robot kinematics and localization techniques by applying predictive modeling, Kalman filters, Bayesian estimation, and demonstrating programming skills using ROS.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	-	2	1	-	-	-	-	-	-	3	-	-
2	3	2	2	-	2	1	-	-	-	-	-	-	1	-	-
3	3	2	1	-	3	1	-	-	-	-	-	-	2	-	-
4	3	1	1	-	2	1	-	-	-	-	-	-	1	-	-
5	2	1	1	-	2	1	-	-	-	-	-	-	3	-	-

UNIT I **9 Hours**

ROBOTS AND END EFFECTORS

Robotics: A brief history, laws of Robotics, Differentiate serial and parallel manipulator - concept of workcell - selection of robot specification - classification of Industrial robot manipulator based on configuration - end-effector mechanism and types.

UNIT II **9 Hours**

KINEMATICS OF ROBOT MANIPULATOR

Representing position and rotation - Dot and Cross product - coordinate frames - rotation in plane - rotation in three dimension - Rotational transformation - Translational transformation - Euler angle, Roll, Pitch, Yaw angles Axis/angle representation - rigid motion - Homogeneous transformation - Denavit-Hartenberg convention - inverse and forward kinematics and problems

UNIT III **9 Hours**

VELOCITY ANALYSIS AND STATIC FORCE ANALYSIS

Representation of Linear and Angular Velocity of Manipulator Links Skew Symmetric matrix representation Velocity Forward Propagation Velocity / Manipulator Jacobian. Static Force Analysis: Force transformation of robotic manipulators - Force Jacobian - Singularity Analysis, Workspace Singularities

UNIT IV **9 Hours**

ROBOT DYNAMICS AND TRAJECTORY PLANNING

Introduction, Lagrangian mechanics, Effects of moments of Inertia, Dynamic equation for two axis planar articulated robot - Trajectory planning, point to point, Continuous path motion

UNIT V **9 Hours**

MOBILE ROBOTICS

Introduction - types of mobile robot - kinematics of wheeled mobile robot - predictive modeling and system identification - kalman filters - bayesian estimation - Localization and mapping - ROS and programming.

Total: 45 Hours

Reference(s)

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics:Technology, Programming and Applications, McGraw Hill Book Company, 2012
2. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2008
3. J.J. Craig, Introduction to Robotics: Mechanics and Control, Prentice Hall Inc. / Pearson Education, 2008
4. Kelly, Alonzo. Mobile robotics: mathematics, models, and methods. Cambridge University Press, 2013
5. R.N. Jazer, Theory of Applied Robotics. Springer, 2010
6. Mark W Spong,Seth Hutchinson, M.Vidyasagar Robot Modeling and Control, Wiley India Edition, New Delhi., Nov, 2006.

22ME046 AUTOMATION SYSTEM DESIGN 3 0 0 3

Course Objectives

- To understand the need for automation across a range of industrial sectors.
- To explain the principles of motion components.
- To study about the technological advancements in transfer lines and automated assembly area.
- To explain the design procedure in automation and comprehend the CIROS software"s system integration process.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Illustrate the fundamentals of process automation and modeling of electromechanical systems using the bond graph technique.
2. Apply engineering principles to select suitable motion components (motors, guides, ball screws) based on inertia calculations and application requirements.
3. Analyze automated assembly lines using takt time, buffer design, and flow line balancing to improve manufacturing efficiency.
4. Design products suitable for high-speed automatic feeding, orienting, and insertion based on established automation rules.
5. Simulate and evaluate automation system designs using CIROS software and assess the economic feasibility of implementation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	1	3	-	-
2	3	2	-	-	-	-	-	-	-	-	-	1	3	-	-
3	2	3	-	-	-	-	-	-	-	-	-	2	3	-	-
4	2	2	3	-	-	-	-	-	-	-	-	1	2	-	-
5	2	-	2	3	3	-	-	-	1	1	-	3	3	-	-

UNIT I **8 Hours**

INTRODUCTION TO PROCESS AUTOMATION

Process Automation-paper industry, packaging industry, food processing industry, Integrated design issues in automation systems, Mechatronics design process-benefits, modelling of electromechanical systems, bond graph technique, Automation migration strategy-building blocks of automation systems.

UNIT II **11 Hours**

SELECTION OF MOTION COMPONENTS

Selection of motor for automation system, Calculation of inertia force for motor, LM Guide ways, Ball screws, Selection from the manufacturers catalogue based on the applications.

UNIT III **9 Hours**

TRANSFER LINES AND AUTOMATED ASSEMBLY

General terminology-takt time, setup time and cycle time, Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines-modular fixturing-Flow line balancing.

UNIT IV **10 Hours**

DESIGN FOR HIGH-SPEED AUTOMATIC ASSEMBLY

Introduction, Design of parts for high-speed feeding and orienting, high speed automatic insertion, Analysis of an assembly, General rules for product design for automation-Application of high-speed automatic assembly.

UNIT V **7 Hours**

SYSTEM INTEGRATION

Issues and systematic approaches, design and simulation using CIROS software, Economics of automation systems design and implementation.

Total: 45 Hours

Reference(s)

1. Mikell P Groove, "Automation Production Systems and Computer Integrated Manufacturing", Pearson education, New Delhi,
2. Geoffery Boothroyd, "Assembly Automation and Product Design", CRC Press, USA, 2016.
3. DevadasShetty , "Mechatronics System Design", PWS Publishing Company, USA, 2010.
4. Wilfried Voss, "A Comprehensible Guide to Servo Motor Sizing", Copperhill Technologies Corporation, Massachusetts, 2007.

22ME047 MATERIAL HANDLING SYSTEMS 3 0 0 3

Course Objectives

- To incorporate competency in system visualization and design.
- To impart the knowledge of various material handling systems.
- To enable students to design a material handling systems.
- To identify the appropriate lifting mechanism for a given application.
- To design material handling systems that is safe, efficient, and effective for a variety of working environments.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply fundamental principles to choose appropriate material handling systems ensuring safety and operational efficiency
2. Analyze the suitability of various hoists and winches for specific industrial applications
3. Compare the functionality of different conveyors and elevators to select optimal systems for defined working environments
4. Investigate appropriate lifting mechanisms to enhance material handling performance in diverse settings.
5. Design safe and efficient material handling systems tailored to specific workplace requirements.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	3	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

MATERIALS HANDLING EQUIPMENT

Importance and principles of material handling. Types of intraplant transport facility and applications. Choice of material handling equipment - Surface and overhead equipment - general characteristics of surface and overhead equipment - AGV- AS/RS

UNIT II **9 Hours**

HOIST AND WINCHES

Basic Principles - Types of Cranes - Jib Cranes - Overhead Travelling Cranes/Bridge Cranes - Gantry Cranes - Wharf Cranes - Pillar Cranes - Tower Cranes - Truck and Wagon Cranes - Crawler Cranes - Railroad/Locomotive Cranes - Floating Cranes - Derricks. Storing equipment like pallets, bins, racks, decking, order picking, positioning equipment.

UNIT III **9 Hours**

CONVEYORS AND ELEVATORS

Belt Conveyors - Definition, General Characteristics, Types, Parts, Design Aspects, Pneumatic Conveyors - Definition, Advantages and Disadvantages. Bucket Elevators - Definition, Specification and Uses, Types of Bucket Elevators, Selection of Elevators, Skip Hoists, Freight Elevators, Lifts.

UNIT IV **9 Hours**

CONVEYORS AND ELEVATORS

Types - description - applications of belt conveyors, apron conveyors and escalators pneumatic conveyors, screw conveyors and vibratory conveyors. Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices.

UNIT V **9 Hours**

DESIGN OF MATERIAL HANDLING SYSTEMS

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of arresting gear - Brakes: shoe. design and applications of belt conveyors, apron conveyors. Design of bucket elevators and fork lift trucks.

FOR FURTHER READING

Occupational safety, Energy efficient machines and systems, Storage methods.

Total: 45 Hours

Reference(s)

1. Alexandrov, M., Materials Handling Equipment, MIR Publishers, Moscow, 1982
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, Bangalore, 2002.
4. P.S.G. Tech.,Design Data Book, Kalaikathir Achchagam, Coimbatore, 2012.
5. Rudenko, N., Materials handling equipment, Elnvee Publishers, New Delhi, 1970.
6. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

22ME048 ARTIFICIAL INTELLIGENCE IN AUTOMATION 3 0 0 3

Course Objectives

- To understand the various characteristics of intelligent agents
- To understand the different search strategies in AI
- To represent knowledge in solving AI problems and understand the different ways of designing software agents
- To know about the various applications of AI

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Illustrate the functions of intelligent agents in different environments using search-based problem-solving methods.
2. Compare robotic paradigms by analyzing their structural and behavioral attributes in control applications.
3. Construct path planning strategies using topological references and metric representations in robotic systems.
4. Simulate localization and mapping techniques using sensor models and probabilistic estimation methods.
5. Interpret the role of learning models and natural language processing in AI-based communication systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	1	2	3	-	-	-	-	-	-	-	-	-	2	-	-
4	1	1	1	3	-	-	-	-	-	-	-	-	2	-	-
5	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **8 Hours**

INTRODUTION TO AI AND INTELLIGENT AGENTS

Foundations, History - Intelligent agents, Agents - Nature of Environments, Structure of agents. Problem solving agents - Problem formulation - State space, Search space. Problem reduction - Searching for solutions: Uninformed search strategies. Informed search strategies - Heuristic functions.

UNIT II **11 Hours**

ROBOTIC PARADIGMS

Overview of the Three Paradigms - Hierarchical Paradigm: attributes - representative architectures - Reactive paradigm: attributes - subsumption architecture - potential field methodologies - Designing a reactive implementation: a primitive move-to-goal behavior, an abstract follow-corridor behavior - Designing a Reactive Behavioral System - The Hybrid Deliberative/Reactive Paradigm- Attributes - Architectural Aspects- Managerial Architectures- State-Hierarchy Architectures Model-Oriented Architectures.

UNIT III **9 Hours**

TOPOLOGICAL AND METRIC PATH PLANNING

Landmarks and gateways - relational methods - associative methods - case study - Metric Planning: Configuration Space -Cspace representations - graph based planners - wavefront based planners - Interleaving Path Planning and Reactive Execution

UNIT IV **10 Hours**

LOCALIZATION AND MAP MAKING

Sonar sensor model-Bayesian-Dampster-Shafer theory-HIMM-comparison of methods-localization-exploration.

UNIT V **7 Hours**

LEARNING AND NATURAL LANGUAGE PROCESSING

Forms of learning-NLP: Language models-Natural language for communications-Speech recognition.

Total: 45 Hours

Reference(s)

1. Robin R. Murphy, "Introduction to AI Robotics", MIT Press, 2000.
2. Start Russell, Peter Norvig, "Artificial Intelligence-A Modern Approach", Pearson Education, New Delhi, 2015.
3. Francis X. Govers, "Artificial Intelligence for Robotics", Packt, 2018
4. Roland Siegwart, Illah R. Nourbakhsh , "Introduction to Autonomous Mobile Robots", MIT Press, 2004.
5. Kevin Knight, Elaine Rich, Nair , "Artificial Intelligence", Tata McGraw Hill, New Delhi, 2017.
6. Jon Gabriel, "Artificial Intelligence: Artificial Intelligence for Humans", 1st Edition, Createspace Independent Publishers, 2016.

22ME049 MACHINE LEARNING IN AUTOMATION 3 0 0 3

Course Objectives

- To Understand the fundamentals of various machine learning algorithms
- To gain knowledge on important methods in ANN, Fuzzy and Genetic algorithm
- To study the machine learning algorithms for various heuristic and non heuristic algorithms.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply machine learning concepts to analyze and contrast supervised and semi-supervised techniques, inferring their suitability for data-constrained intelligent systems.
2. Interpret the roles of unsupervised and reinforcement learning algorithms and illustrate their application in developing adaptive artificial learning systems.
3. Demonstrate the working principles of artificial neural networks and apply them in real-time control system applications within defined engineering constraints.
4. Design fuzzy logic-based knowledge representation schemes and multi-objective decision-making controllers for intelligent systems in dynamic environments.
5. Formulate and simulate the application of heuristic and non-heuristic algorithms to solve complex optimization problems in intelligent control systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	1	-	-	-	-	-	-	-	3	-	2
2	3	-	-	-	1	-	-	-	-	-	-	-	2	-	1
3	3	2	2	-	1	-	-	-	-	-	-	-	2	-	1
4	2	2	3	-	3	-	-	-	-	-	-	-	2	-	2
5	1	2	2	3	3	-	-	-	-	-	-	-	2	-	2

UNIT I **9 Hours**

SUPERVISED AND SEMI SUPERVISED LEARNING METHODS

Introduction to learning & classifiers - LDA - ANN - Naive Bayes classifier- decision tree Regression- Ordinary Least Squares - linear and Logistic Regression- Gaussian process -Stepwise Regression - Multivariate Adaptive Regression Splines (MARS) - Locally Estimated Scatterplot Smoothing (LOESS) - overview of nearest neighbour - Support vector machines- Temporal difference learning - Q-learning

UNIT II **9 Hours**

UNSUPERVISED

Expectation -maximization (EM) - Vector quantization, Clustering Fuzzy K & C means algorithm - Density-based spatial clustering of applications with noise (DBSCAN) - Conceptual clustering- Association rule learning - Apriori algorithm- SVD

UNIT III **9 Hours**

NEURAL NETWORK

Perceptron - Probabilistic Neural Network (PNN) - Back-Propagation (BPN) - Hopfield Network - Self-Organizing Map (SOM) - Learning Vector Quantization (LVQ) -Adaptive Resonance Theories 1 & 2 - Case studies on GA based algorithm development

UNIT IV **9 Hours**

FUZZY CLASSIFICATION

Basic concepts in Fuzzy Set theory-Fuzzy logic controllers - Principles - Various industrial Applications of Fuzzy logic control - Adaptive Fuzzy systems - Fuzzy Decision making - Fuzzy classification - Fuzzy pattern Recognition - Image Processing applications - Fuzzy optimization - Case studies on fuzzy based algorithm development

UNIT V **9 Hours**

HEURISTIC AND NON HEURISTIC ALGORITHMS

Introduction to genetic algorithm -initialization, selection, mutation and termination Swarm intelligence - PSO-ACO - Tabu search - Reactive search optimization (RSO)- cross-entropy (CE) methods. Case studies on GA based algorithm development.

Total: 45 Hours

Reference(s)

1. Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, London.2014.
2. Klir, G.J. Yuan Bo, Fuzzy sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Pvt. Ltd.New jersey. 2005
3. Randy L. Haupt, Sue Ellen Haupt Practical Genetic Algorithms, Wiley interscience 2004
4. S. Rajasekaran, GA Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, Prentice Hall of India Private Limited, 2003
5. Simon Haykin, Neural Networks - A comprehensive foundation, Prentice Hall, 3rd Edition, 2004
6. https://onlinecourses.nptel.ac.in/noc18_cs26/course

22ME050 VIRTUAL INSTRUMENTATION SYSTEMS 3 0 0 3

Course Objectives

- To impart knowledge in studying virtual instrumentation.
- To understand the basic building blocks of virtual instrumentation.
- To understand the various techniques of interfacing of external instruments of PC.
- To understand the various graphical programming environment in virtual instrumentation
- To apply few applications in virtual instrumentation

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the principles of Virtual Instrumentation to design and develop basic VI's using LabVIEW with front panel and block diagram components.
2. Investigate the LabVIEW programming structures like loops, arrays, and clusters to build functional subVIs for engineering applications.
3. Demonstrate the integration of sensors, transducers, and DAQ hardware to acquire and process real-time data in a virtual instrumentation system.
4. Analyze and utilize standard communication interfaces like RS232, GPIB, and USB using VISA programming for instrument control and data exchange.
5. Develop VI-based applications such as remote monitoring, machine vision, and motion control systems using LabVIEW tools and evaluate their performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
5	2	-	2	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

VIRTUAL INSTRUMENTATION SYSTEM INTRODUCTION

Definition and Architecture of Virtual Instrumentation - Virtual Instruments Versus Traditional Instruments - Conventional Virtual Instrumentation - Virtual Instruments using LabVIEW - Virtual Instrumentation in the Engineering process. Virtual Instrumentation System Environment- Front panel and Block Diagram - Tools palette - Data flow programming - "G" programming - Data types and Conversion - Representation and precision - Creating and saving VIs - Writing - Editing - Debugging and Running a VI - Creating subVIs

UNIT II **9 Hours**

PROGRAMMING STRUCTURES

FOR loop - WHILE loop - Shift register - Feedback node - CASE structure - Sequence structures - Formula nodes - Arrays - Array operations - Clusters - Cluster functions - Waveform Graphs and Waveform Charts - Strings - String functions -File I/O - File I/O Functions - Attribute modes: Local and Global variables

UNIT III **9 Hours**

I/O AND HARDWARE ASPECTS

Components of measuring system - Classification of signals - Transducers and sensors - Signal conditioning functions - Signal Grounding - Digital I/O techniques - Data Acquisition using VI - Components of DAQ - DAQ Assistant - Measurement and Automation Explorer - DAQ Hardware and Software

UNIT IV **9 Hours**

INSTRUMENT INTERFACES AND BUSES

Drivers and Communication standards -RS232- GPIB: Types of GPIB messages - Physical Bus structure - VISA Programming - VISA Attributes - USB: Architecture - Electrical specifications - Functions

UNIT V **9 Hours**

APPLICATIONS OF VIRTUAL INSTRUMENTATION

Developing Remote front panel VI applications - Client server applications in VI - Machine vision system - Introduction to image processing modules - Motion Control: Components of a motion control system - Software for configuration - Prototyping and Development

Total: 45 Hours

Reference(s)

1. Sumathi S., P Surekha, "LabVIEW based Advanced Instrumentation Systems", Springer, 2007
2. Jeffrey Travis, Jim Kring , "LabVIEW for Everyone", Prentice Hall, 2009.
3. Jovitha Jerome, "Virtual Instrumentation Using Lab VIEW", Prentice Hall of India, 2011.
4. Christopher G Relf, "Image Acquisition and Processing with LabVIEW", CRC Press, 2004.
5. Rick Bitter, Taqi Mohiuddin , Matt Nawrocki , "LabVIEW Advanced Programming Techniques", CRC Press, 2006.
6. Robert H. Bishop, "Learning with LabVIEW", 1st Edition, Pearson, 2014.

22ME051 AUTOMATIC CONTROL SYSTEMS 3 0 0 3

Course Objectives

- To understand the control system representation
- To analyze the control system in terms of time domain specifications
- To analyze the control system in terms of frequency domain specifications
- To understand the state space analysis of control systems
- To determine the stability of a control system from its transfer function

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications..

Course Outcomes (COs)

1. Apply control system concepts to construct block diagrams and signal flow graphs for effective system representation.
2. Investigate the time response of control systems using time-domain specifications to evaluate system performance
3. Compare the frequency response of control systems using frequency-domain specifications for performance evaluation
4. Design control system models using state-space representation and analyze their dynamic behavior to develop stable and efficient control solutions.
5. Analyze the stability characteristics of control systems using methods such as Routh-Hurwitz and Nyquist criteria to assess system performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	1	2	-
2	2	3	-	-	-	-	-	-	-	-	-	-	1	2	-
3	2	3	-	-	-	-	-	-	-	-	-	-	1	2	-
4	2	2	3	-	-	-	-	-	-	-	-	-	1	2	-
5	2	3	-	-	-	-	-	-	-	-	-	-	1	2	-

UNIT I **9 Hours**

INTRODUCTION

Components of Automatic control systems- Open loop and closed loop systems - Examples - Transfer function - Modeling of physical systems - Mechanical Systems - Translational and Rotational systems - Hydraulic systems and Electrical Systems - Transfer function of DC servomotor - AC servomotor - Block diagram - reduction techniques - Signal flow graph - Mason"s gain formula.

UNIT II **9 Hours**

TIME DOMAIN ANALYSIS

Continuous time signals - Standard Test signals - Classification of continuous time systems - Linear-Nonlinear - Time variant - Time invariant - Static - Dynamic - Time response of second order system - Time domain specifications - Types of systems - Steady state error constants -Generalized error series - Introduction to P, PI and PID modes of feedback control. - Introduction to lead, lag and lead-lag compensators.

UNIT III **9 Hours**

FREQUENCY DOMAIN ANALYSIS

Frequency domain specifications - Estimation for second order systems- Correlation between time and frequency domain specifications for second order systems - . Bode plot - Determination of Transfer Function from Bode plot - All pass minimum phase and non-minimum phase systems - Polar plot - Determination of gain and phase Margins from the plots.

UNIT IV **9 Hours**

STATE SPACE ANALYSIS

Limitations of conventional control theory - Concepts of state, state variables and state model - state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables - State equations - Transfer function from the State model - Solutions of the state equations -State Transition Matrix - Concepts of controllability and observability.

UNIT V **9 Hours**

SYSTEM STABILITY

Concept of stability - stability & location of the poles in S-plane - Characteristic equation - RouthHurwitz stability criterion - Root Locus concepts- Construction of root locus - Root contours - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability - Gain and Phase Margin.

Total: 45 Hours

Reference(s)

1. Smarajit Ghosh,"Control Systems Theory and Applications", 2nd Edition, Pearson Education, New Delhi, 2012.
2. Katsuhiko Ogata,"Modern Control Engineering", Pearson India Education, 2015.
3. S.Salivahanan, R.Rengaraj, and G.R.Venkatakrishnan, "Control systems Engineering", Pearson India Education, 2015.
4. Nagarath, I.J. and Gopal, M.,"Control Systems Engineering", New Age International Publishers, 2017.
5. RamesC.Panda and T. Thyagarajan,"An Introduction to Process Modelling Identification and Control of Engineers", Narosa Publishing House, 2017.
6. NPTEL Video Lecture Notes on "Control Engineering" by Prof. S. D. Agashe, IIT Bombay.

22ME052 INDUSTRIAL NETWORKING 3 0 0 3

Course Objectives

- To understand the division of network functionality into layers.
- To familiarize the functions and protocols of each layer of TCP/IP protocol suite.
- To understand the components required to build different types of network.
- To learn concepts related to network addressing.
- To understand the flow of information from one node to another node in the network and to learn the application layer utilities.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply industrial networking standards like EIA-232 and EIA-485 to implement noise-free network configurations.
2. Analyze communication bus protocols like Modbus and CAN to optimize data transmission.
3. Design Ethernet-based industrial networks using IEEE 802.3 and TCP/IP to integrate LAN systems.
4. Investigate wireless communication technologies like Wireless HART and RFID to validate industrial applications.
5. Develop automotive and train communication networks using LIN and IEC/IEEE standards to enhance reliability.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	3	-	-	-	-	1	-	1	-	-	3
2	-	3	-	3	2	-	-	-	-	-	-	1	-	3	2
3	-	-	3	-	3	1	-	-	-	1	1	-	3	-	3
4	-	2	-	3	1	-	1	-	-	-	-	1	-	3	3
5	3	-	3	1	1	-	-	-	-	-	1	1	3	1	-

UNIT I **10 Hours**

INTRODUCTION

Modern instrumentation and control systems - Terminology - Topology - Mechanisms - Protocols - Standards - Common problems and solutions - Grounding/shielding and noise - EIA-232 interface standard - EIA-485 interface standard - Current loop and EIA-485 converters - Fibre optic cable components and parameters - Basic cable types - Connection fibers - troubleshooting.

UNIT II **10 Hours**

COMMUNICATION BUS PROTOCOLS

Overview - Protocol structure - Function codes - Modbus plus protocol - Data Highway - AS interface (AS-i)-DeviceNet: Physical layer - Topology - Device taps - Profibus PA/DP/FMS: Protocol stack - System operation. CAN BUS: Concepts of bus access and arbitration - CAN: Protocol-Errors: Properties - detection - processing - Introduction to CAN 2.0B and EtherCAT.

UNIT III **10 Hours**

ETHERNET SYSTEMS

IEEE 802.3 - Physical layer - Medium access control - Collisions - Ethernet design rules - Fast and gigbit Ethernet systems - design considerations - Internet layer protocol - UDP - TCP/IP - ProfiNet - LAN system components - Structured cabling - Industrial Ethernet - Troubleshooting Ethernet.

UNIT IV **8 Hours**

WIRELESS COMMUNICATIONS

Radio spectrum - Frequency allocation - Radio modem - Intermodulation - Implementing a radio link - RFID: Basic principles of radio frequency identification - Transponders - Interrogators - Wireless HART.

UNIT V **7 Hours**

APPLICATIONS

Automotive communication technologies - Design of automotive X-by-Wire systems - The LIN standard - The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations.

Total: 45 Hours

Reference(s)

1. Shibu. K.V, "Introduction to Embedded Systems", 2e, Mcgraw Hill, 2017.
2. Raj Kamal, "Embedded System-Architecture, Programming, Design", McGraw Hill, 2013.
3. Lyla B Das,"Embedded Systems-An Integrated Approach", Pearson, 2013
4. C.R.Sarma, "Embedded Systems Engineering", University Press (India) Pvt. Ltd, 2013.
5. James Powell, Henry Vandelinde , "Catching the Process Fieldbus an Introduction to PROFIBUS for Process Automation", Momentum Press, 2013.
6. Albert Lozano-Nieto , "RFID Design Fundamentals and Applications", CRC Press, 2011.

22ME053 AUTOMOTIVE SYSTEM 3 0 0 3

Course Objectives

- To impart knowledge on the constructional details and principle of operation of various automobile components.
- To provide knowledge on the working of fuel supply and engine auxiliary system in various automobiles.
- To learn the function of various components in transmission and drive lines of a vehicle
- To study the concept and working of steering, brakes and suspension systems in automobile.
- To impart knowledge on electrical and electronic systems of automobiles.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional features of key automobile components.
2. Illustrate the working of fuel supply systems and engine auxiliary units in internal combustion engines.
3. Investigate the functions and interactions of components in vehicle transmission and driveline systems.
4. Assess the types of steering, and braking systems used in automobiles to understand vehicle control and safety mechanisms.
5. Analyze the suspension types and emission control technologies in vehicles to ensure compliance with environmental norms and ride quality.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	-	-	1	-	-	-	-	-	1	-	2	-
2	2	-	-	-	-	1	2	-	-	-	-	1	-	2	-
3	2	2	-	-	-	-	-	-	-	-	-	1	-	2	-
4	2	-	-	-	-	1	-	-	-	-	-	1	-	2	-
5	2	2	-	2	-	1	2	-	-	-	-	1	-	2	-

UNIT I **9 Hours**

VEHICLE BODY AND AERODYNAMICS

Types of Automobiles - vehicle construction, chassis, frame and body. Vehicle aerodynamics -aerodynamic drag, lift and methods of reducing.

UNIT II **9 Hours**

FUEL SUPPLY MANGEMENT SYSTEMS

Spark ignition engine - Electronic fuel injection system, mono-point and multi Point injection systems. Compression ignition engine- Inline fuel injection system, Common rail direct fuel injection system.

UNIT III **9 Hours**

FUEL SUPPLY MANGEMENT SYSTEMS

Clutch - Types. Gearbox - Types. Automatic transmission system. Fluid flywheel, torque convertors, propeller shaft, slip joint, universal joints, differential and rear axle drives - hotch kiss drive and torque tube drive.

UNIT IV **9 Hours**

STEERING SYSTEM AND BRAKING SYSTEM

Wheels and Tyre Construction. Steering geometry, types of steering and Power steering. Braking Systems -Types-disc brake, drum brake, hydraulic brake and air brake. Electronic Brake Distribution (EBD)

UNIT V **9 Hours**

SUSPENSION SYSTEMS AND EMISSION CONTROL SYSTEMS

Suspension systems - Types - rear suspension and front suspension. Active Suspension System(ASS). Engine emission control - Three-way catalytic converter, Smoke reduction methods. Euro Emission norms and BS Emission norms.

FOR FURTHER READING

Electronic Stability Program(ESP), Traction Control System (TCS), Global Positioning System (GPS), Electric, Hybrid vehicle.

Total: 45 Hours

Reference(s)

1. Crouse and Anglin, Automotive Mechanism, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
2. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers, 2000.
3. S. Srinivasan, Automotive Mechanics, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003
4. Joseph Heitner, Automotive Mechanics, East-West Press, 2006.
5. H. M. Sethi, Automobile Technology, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2007.
6. Kirpal Singh, Automobile Engineering Volume.1 and 2, Standard Publishers, New Delhi,2013.

22ME054 AUTOMOTIVE ELECTRONIC SYSTEMS 3 0 0 3

Course Objectives

- To understand the concepts of Automotive Electronics and its trends
- To understand the concepts of Automotive Electricals and its trends
- To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms.
- To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.
- To describe various communication systems, wired and wireless protocols used in vehicle networking.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply the principles of automotive electronics to systems such as power supply controllers, suspension controls, safety systems, and infotainment modules in modern vehicles.
2. Assess the operation of electrical subsystems in automobiles including electric drives, starter mechanisms, alternators, and power steering systems for their functional efficiency and reliability.
3. Compare different neural network models such as Perceptron, Adaline, Madaline, and Convolutional Neural Networks in terms of structure, learning methods, and application in automotive systems.
4. Analyze the real-time operating system (RTOS) components and features to understand task scheduling, synchronization, and inter-task communication in embedded automotive environments.
5. Investigate communication protocols such as SPI, I2C, CAN, LIN, and AUTOSAR used in automotive embedded systems to evaluate their role in control and data exchange.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	2	2	2	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

ELECTRONICS IN AUTOMOBILE

Introduction - vehicle power supply controllers and lighting modules, door control modules, Electronic control of suspension, Safety electronics: active safety systems: ABS, ASR, ESP, Infotainment electronics: car audio, telematics systems, navigation systems, multimedia systems.

UNIT II **9 Hours**

ELECTRICALS IN AUTOMOBILE

Electric drives- AC drives, DC drives, Starter drive mechanisms, Starter Switches and Solenoids, Electric power steering, Charging circuits for D.C. Generator, A.C. Alternators.

UNIT III **9 Hours**

AUTOMOTIVE NEURAL NETWORKS

ANN, artificial and biological neuron, learning (supervised and unsupervised learning). McCulloh-Pitts neuron, Linear separability, Hebb network. Perceptron Network, Adaline, Medaline. Convolution Neural Networks- Feed Forward networks, Back propagation network.

UNIT IV **9 Hours**

REAL TIME OPERATING SYSTEM (RTOS)

Introduction - RTOS. Tasks & task states (Pre-emptive & Non-pre-emptive, scheduler, interrupt -Interrupt latency and context switch latency) - Task, multi-tasking, task synchronization, inter-task communication, shared data problem and its prevention - Features of a typical embedded RTOS (MuC/OS-II).

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction to control networking-Communication protocols in embedded systems-SPI, I2C, USB. Vehicle communication protocols-Introduction to CAN, LIN, FLEXRAY, MOST, AUTO SAR.

Total: 45 Hours

Reference(s)

1. Robert Bosch,Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, Springer Vieweg ,Plochingen, Germany, 2014.
2. William B Ribbens, Understnading Automotive Electronics- An Engineering Persepective, The Boulevard, Langford Lane, Kidlington, Oxford, 2017.
3. Barry Holembeak, Automotive Electricity and Electronics Delmar Publishers, Clifton Park, USA, 2010.
4. James D Halderman, Automotive Electricity and Electronics, Prentice Hall, USA, 2013.
5. Al Santini, Automotive Electricity and Electronics, Delmar Learning, 2011.
6. Charu C. Aggarwal Neural Networks and Deep Learning: A Text Book

22ME055 ELECTRIC AND HYBRID VEHICLE SYSTEMS 3 0 0 3

Course Objectives

- To introduce fundamental concepts and specifications of electric and hybrid vehicles
- To acquire knowledge technologies related to electric, hybrid and fuel cell powered vehicles
- To appreciate the role of electronics in providing improved control to a variety of vehicle systems
- To Measure and Estimate the energy consumption of the Hybrid Vehicles.
- To Identify various energy source options like fuel cell and hydrogen storage system

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply the fundamentals of vehicle usage patterns and environmental impacts to identify the need for next-generation transportation technologies.
2. Demonstrate the functional layout, drive train topologies, and regenerative features of electric and hybrid vehicles for various transport applications.
3. Select appropriate electric propulsion systems and motor drives for various electric vehicle applications based on performance requirements.
4. Analyse the energy storage principles to recommend suitable storage technologies for efficient energy management in EVs and HEVs.
5. Interpret the working principles and configurations of different fuel cell technologies for application in sustainable electric mobility.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	2	-	-	-	-	2	-	-	2
2	3	-	-	-	-	-	2	-	-	-	-	2	-	-	2
3	3	-	-	-	-	-	2	-	-	-	-	2	-	-	2
4	2	3	-	-	-	-	2	-	-	-	-	2	-	-	2
5	3	-	-	-	-	-	2	-	-	-	-	2	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Usage Pattern of Automobiles in cities and highways, Air Pollution: NOx, CO, HC, PM emission, Global Warming Health Impacts, Petroleum Resources, Induced Costs, Importance of Different Transportation Development, Strategies to Future Oil Supply, Strategies for Next Generation Vehicles.

UNIT II **9 Hours**

ELECTRIC AND HYBRID VEHICLES

Configuration Layouts of early EVs and modern EVs, merits and demerits, Concept of Hybridization, Hybrid electric drive trains - types of hybrid drive train topologies, Speed & Torque Couplings, Types of HEVs, Regenerative braking strategies, Start/Stop in EVs and HEVs, Merits and demerits

UNIT III **9 Hours**

PROPULSION SYSTEM FOR EVS

Basic concept of electric traction, Power-Torque Characteristic curves, Selection of Electric motors, Motors types: DC motor drives, induction motor drives, brushless DC PM motor drives, Switched Reluctance motor drives, starter/alternator, Electric Control Drives.

UNIT IV **9 Hours**

ENERGY MANAGEMENT SYSTEM FOR EVS

Energy storage requirements in HEVs and EVs, Energy storage techniques - battery based energy storage: Engine starter batteries, Traction Batteries, Super capacitor based energy storage and flywheel based energy storage, Hybridization of different energy storage devices

UNIT V **9 Hours**

FUEL CELL TECHNOLOGIES

Fuel cell electric vehicles-operating principle, Fuel cell technologies- alkaline fuel cell- proton exchange Membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Fuel reformer, Hydrogen storage systems

Total: 45 Hours

Reference(s)

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2018
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Boca Raton: CRC Press, 2011
3. AuliceScibioh M. and Viswanathan B., Fuel Cells Principles and Applications, India: University Press, 2009
4. Barbir F., PEM Fuel Cells: Theory and Practice, Burlington: Elsevier, 2012.
5. James Larminie and John Loury, Electric Vehicle Technology-Explained, New York: John Wiley & Sons Ltd., 2012
6. https://nptel.ac.in/courses/108103009/

22ME056 VEHICLE DYNAMICS AND CONTROL 3 0 0 3

Course Objectives

- To acquire knowledge on road vehicle dynamics, stability and handling
- To develop an understanding of the relationships between vehicle design variables and vehicle dynamic behaviour
- To apply modeling techniques to predict the dynamic behavior of road vehicles
- To calculate and refer the loads and forces associated to the vehicles
- To analyse the behavior of the vehicles under acceleration, ride and braking

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply fundamental concepts of vehicle dynamics and vibration theory to analyze dynamic axle loads, road loads, and equations of motion for single, two, and multi-degree-of-freedom systems under various driving conditions.
2. Implement performance mode concepts to evaluate vehicle acceleration, deceleration, and braking behavior using free body diagrams, and assess the impact of systems like ABS and traction control on vehicle performance.
3. Evaluate human response to vibration and assess the performance of passive, semi-active, and active suspension systems using various vehicle models and control strategies.
4. Assess tire dynamics by evaluating tire forces, slip characteristics, road surface interactions, and vibration behavior to assess tire performance under varying operating conditions
5. Analyze vehicle handling characteristics by assessing steering behaviors, control parameters, and the influence of braking and dynamic responses on steady-state and low-speed vehicle control.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	1	-	-	-	-	-	1	2	-	-
2	3	2	2	-	-	1	-	-	-	-	-	1	2	-	-
3	2	2	3	-	-	1	-	-	-	-	-	1	2	-	-
4	3	2	2	-	-	1	-	-	-	-	-	1	2	-	-
5	2	2	3	-	-	1	-	-	-	-	-	1	2	-	-

UNIT I **9 Hours**

INTRODUCTION

Vehicle and Earth fixed coordinate system, Euler angles, Dynamic axle loads - static loads on level ground - low speed acceleration, Loads on Grades. Road loads - rolling resistance - grade resistance. Equation of motion for Forced Undamped and forced Damped Vibration, Single DOF, Two DOF and Multi DOF systems

UNIT II **9 Hours**

PERFORMANCE MODE

Acceleration - free body diagram of accelerating vehicle, maximum transferable tractive force and gradability. Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance and maximum braking force. Prediction of Vehicle performance. Antilock Brake Systems, Traction control

UNIT III **9 Hours**

RIDE MODE

Human response to vibration, Sources of Vibration. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-infinite and skyhook damping. Air suspension system and their properties

UNIT IV **9 Hours**

TIRE DYNAMICS

Tire forces and moments, tire structure, longitudinal and lateral force at various slip angles, rolling resistance, tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on various road surfaces. Tire vibration

UNIT V **9 Hours**

HANDLING MODE

Vehicle control - low speed cornering and static steering - Steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slip angle steer. Steady state handling - lateral acceleration gain, characteristic speed, yaw velocity gain and critical speed. Effect of braking on vehicle handling

Total: 45 Hours

Reference(s)

1. H.Pacejka, Tire and Vehicle Dynamics, Oxford: Butterworth-Heinemann Elsevier Ltd, 2012
2. R.N. Jazar, Vehicle Dynamics: Theory and Application, NY: Springer, 2017.
3. T.D. Gillespie, Fundamentals of Vehicle Dynamics, Michigan: SAE International, 1992.
4. J.Y. Wong, Theory of Ground Vehicles, John Willey & Sons, 2008.
5. D. Karnopp, Vehicle Dynamics, Stability and Control, Boca Raton: CRC Press, 2013.
6. https://nptel.ac.in/courses/107106080/

22ME057 INTELLIGENT VEHICLE SYSTEM 3 0 0 3

Course Objectives

- To understand concept of autonomous and connected vehicle
- To learn about sensor technology of automated vehicle
- To understand about computer vision and deep learning
- To acquire knowledge on localisation and path planning
- Become familiar with the concept of connected vehicles

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Interpret the role of automotive electronic systems, intelligent vehicle features, and control systems in the context of emerging trends and the need for autonomy in modern vehicles.
2. Analyze the application of computer vision, neural networks, and sensor fusion techniques for accurate environment perception and decision-making in autonomous systems.
3. Investigate the connected vehicle technologies, communication frameworks (V2V, V2I), and cybersecurity aspects to evaluate their impact on safety, user experience, and system integration.
4. Develop IoT-integrated automotive platforms combining diagnostics, driver monitoring, and vehicle analytics to address intelligent mobility and vehicle management needs.
5. Construct autonomous vehicle support systems such as adaptive cruise control, automatic parking, and driver aid technologies by integrating hardware, software, and control logic for enhanced comfort and safety.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
3	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

INTRODUCTION

Introduction to the Concept of Automotive Electronics, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance Electronic Systems Basic Control System Theory applied to Automobiles-Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT II **9 Hours**

COMPUTER VISION AND DEEP LEARNING

Introduction, Computer Vision: - Computer Vision Fundamentals, Deep Learning:- Neural Networks, Deep Neural Networks, Convolutional Neural Networks, Keras ,TensorFlow, Sensor Fusion:- Kalman Filters

UNIT III **9 Hours**

CONNECTED CAR TECHNOLOGY

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Wireless Security Overview Connected Car Display Technology- Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, Warning Technology-Driver Notification

UNIT IV **9 Hours**

IOT IN AUTOMOBILES

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Real Time Driver Monitor, Geo fencing and Speed Monitoring, Stolen Vehicle Tracking, Biometrics Information for Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation , Introduction to Autonomous Vehicle.

UNIT V **9 Hours**

AUTONOMOUS VEHICLE COMFORT SYSTEMS AND APPLICATIONS

Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system- ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.

Total: 45 Hours

Reference(s)

1. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner , Autonomous Driving: Technical, Legal and Social Aspects, Springer,2016
2. Hod Lipson, Melba Kurman,Driverless: Intelligent Cars and the Road Ahead,MIT press, 2016
3. Michael E. McGrath , Autonomous Vehicles: Opportunities, Strategies,and disruptions, 2016
4. Vivekwadhwa , Alex salkever, The driver in the driverless car, 2017
5. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson- Delmar Learning, ISNB#1-4018-8659-0, 2006
6. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN#1-4018-4339-5, 2003

22ME058 VEHICLE MAINTENANCE 3 0 0 3

Course Objectives

- To impart the knowledge on safety and tools used in workshop.
- To learn about the maintenance procedure of engine and engine subsystems.
- To provide the knowledge on transmission and driveline maintenance procedure.
- To impart the knowledge on the maintenance procedure of steering, brake, suspension and wheel maintenance.
- To learn about electrical and air conditioning maintenance procedure.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Assess workshop maintenance practices, safety measures, and tools used.
2. Implement the maintenance procedures for engines and their subsystems.
3. Analyze he maintenance procedures for transmission and driveline systems.
4. Demonstrate maintenance process steps for steering, brake, suspension, and wheel systems.
5. Evaluate the maintenance techniques for electrical and air conditioning systems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
3	2	3	2	-	-	-	-	-	-	-	-	-	3	-	-
4	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	2	3	-	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

MAINTENANCE WORKSHOP PRACTICES SAFETY AND TOOLS

Maintenance- Need, Importance, Primary and secondary functions, Policies,- Classifications of maintenance work - Vehicle Insurance - basic Problem Diagnosis. Automotive Service procedures- Work shop operations-Workshop manual- Vehicle identification. Safety- Personnel, Machines, and equipment, vehicles, fire safety- First aid. Basic tools, Special service tools, Measuring instruments, Condition checking of seals, gaskets and sealants. Scheduled maintenance services- service intervals - towing and recovering.

UNIT II **9 Hours**

ENGINE AND ENGINE SUBSYSTEM MAINTENANCE

General Engine service- Dismantling of Engine components- Engine repair - Working on the ancillaries- service of basic engine parts, cooling and lubricating system, Fuel system, Intake and exhaust systems, Electrical system- Electronic fuel injection and engine management service - Fault diagnosis -servicing emission controls.

UNIT III **9 Hours**

TRANSMISSION AND DRIVELINE MAINTENANCE

Clutch- general checks, adjustment and service -Dismantling, Identifying, Checking and assembling of transmission, transaxle- road testing -removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joint - Rear axle service points -Removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

UNIT IV **9 Hours**

STEERING, BRAKE, SUSPENSION ANDWHEEL MAINTENANCE

Inspection, Maintenance and service of steering linkage, steering linkage, steering column, rack and pinion steering, recirculating ball steering service- worm type steering, power steering system. Inspection, maintenance and service of hydraulic brake, drum brake, disc brake, parking brake, bleeding of brakes. Inspection, Maintenance and service of McPherson strut, coil spring, leaf spring, shock absorber, Dismantling and assembling procedures. Wheel alignment and balance, Removing and fitting of tyres, tyre wear and tyre rotation.

UNIT V **9 Hours**

ELECTRICAL, AIR CONDITIONING AND BODY MAINTENANCE

Maintenance of batteries, starting system, charging system and body electrical- Fault Diagnosis using scan tools. Maintenance of Air conditioning parts- compressor, condenser, expansion valve, evaporator- replacement of hoses- leak detection - AC Charging - Fault Diagnosis. Vehicle Body repair- panel beating, tinkering, soldering, polishing, painting.

Total: 45 Hours

Reference(s)

1. Ed May, Automobile Mechanics Volume one, McGraw Hill Publications, 2003.
2. Ed May, "Automotive Mechanics Volume Two" , Mc Graw Hill Publications, 2003
3. Crouse W H, Automotive Transmissions and Power Trains, McGraw Hill Book Co., 5th edition, 1976.
4. Bosch Automotive Handbook, Tenth Edition, 2018

22ME0XA MODELLING AND ANALYSIS OF COMPLEX GEOMETRIES 1 0 0 1

Course Objectives

- To learn the basic principles of modelling and analysis of complex geometries.
- To identify the application and characteristics of Hypermesh in various industries.
- To understand the polyhedral, Tetrahedral and hexahedral cell shape based core meshes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the concepts learned to solve real-world engineering problems in various industries.
2. Analyze the specific finite element models using problem solving skills.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-

15 Hours

Introduction, Basic to FEA - Overview in finite element evolution and why, Design Process - Steps involved in the Design process and impact of FEA in the design process, Basic handling of hyper mesh, hyper mesh tool overview, Usage and development of Finite element analysis in various sectors. Pre-Processing Hands-on hyper mesh- Geometry handling, Mesh Handling, 2D- Mesh (Shell Meshing) Sheet, Plastics (trims), How to Mesh Plastic components and assigning thickness factor, 3D- Mesh (Volume and Beam meshing). Tetra Modelling - components suitable for tetra meshing. Hexa Modelling - Components suitable for Hexa - Overview in various domains NVH, Durability, CFD, and Crash- Connections

Total: 15 Hours

Reference(s)

1. P. Seshu, “Textbook of Finite Element Analysis,” PHI Learning Pvt. Ltd., New Delhi, 2004
2. https://altairuniversity.com/free-ebooks/
3. Practical Aspects of Finite Element Simulation, A Study Guide, Altair University,
4. Jacop Fish, A First Course in Finite Element, 2007, John Wiley and Sons Ltd.
5. J. N. Reddy, “An Introduction to the Finite Element Method,” 3rd Edition, McGraw-Hill, New York, 2005.
6. https://altairuniversity.com/wp-content/uploads/2014/02/meshing.pdf
7. https://www.ics.uci.edu/~eppstein/280g/Bern-Plassman-meshgen.pdf
8. https://altairuniversity.com/free-ebooks/free-ebook-practical-aspects-of-finite-element-simulation-a-study-guide/
9. https://imechanica.org/files/HM%20Advanced%20Training.pdf

Expert detail

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22ME0XB INDUSTRIAL IoT SMART TECHNOLOGY 1 0 0 1

Course Objectives

- To explore IoT technologies and Setting up IoT Devices and Networks
- To provide hands-on training on implementing IoT solutions.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the fundamental concepts, key technologies, system architecture, and emerging trends in Industrial IoT (IoT), including the role of 5G, digital twins, and blockchain.
2. Develop and deploy basic IoT applications by configuring devices, establishing connectivity, collecting and analyzing data using cloud platforms, and integrating with cloud services.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	1	-	-	-	-	-	-	1	2	-	-
2	2	2	2	-	1	-	-	-	-	-	-	1	2	-	-

15 Hours

Introduction to Industrial IoT, Key Technologies in IoT, Industrial Applications of IoT. IoT System Architecture - Reference Models and Frameworks, Edge Computing vs. Cloud Computing. Design Considerations - Scalability and Flexibility, Interoperability and Integration. 5G and its Impact on IoT, Digital Twins, Blockchain in IoT. Case Studies and Examples - Real-world Implementations. Hands-on Labs and Practical Implementation: Setting up IoT Devices and Networks - Configuring Sensors and Actuators, Establishing Connectivity. Data Collection and Analysis - Using Cloud Platforms for Data Storage, Performing Data Analytics. Developing IoT Applications - Basic Programming for IoT Devices, Integrating with Cloud Services.

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Total: 15 Hours

Reference(s)

1. Industrial Internet of Things: Cyber manufacturing Systems, by Sabina Jeschke, Christian Brecher, Houbing Song, and Danda B. Rawat
2. Building the Internet of Things, by Maciej Kranz
3. IIoT World (iiot-world.com)
4. Industrial IoT Consortium (iiconsortium.org)
5. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Wiley, Hoboken, NJ, 2016
6. Sravani Bhattacharjee, Shyam Sundar Ramasamy, Practical Industrial Internet of Things Security: A practitioner's guide to securing connected industries, Packt Publishing, Birmingham, UK, 2018

Expert detail

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22ME0XC AUTONOMOUS ROBOT KINEMATICS AND CONTROL IN ROS 1 0 0 1

Course Objectives

- Apply the technical challenges in the kinematic model and design of autonomous robots in the ROS platform.
- Develop the control algorithm for navigation, path planning and obstacle avoidance for mobile robots using Python/C++ in ROS.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply the fundamentals of ROS architecture by writing basic ROS programs, implementing robot models using URDF, and visualizing sensor data and robot simulations using Rviz and Gazebo.
2. Analyze SLAM-based navigation systems in ROS by evaluating localization, odometry, path planning, and obstacle avoidance using algorithms.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	1	-	-	-	-	-	-	1	2	-	-
2	2	2	2	-	1	-	-	-	-	-	-	1	2	-	-

15 Hours

Robot Model and sensor data visualization: Getting started with ROS, ROS architecture and commands: Master, nodes, topics, messages, services, parameters and actions, Writing ROS programs, ROS Turtlesim, ROS Tools: Rviz and Gazebo, Keyboard Control/TeleOp of turtlesim, LIDAR Data. Rviz visualization - Robot model stl file - URDF robot model implementation. SLAM algorithm in ROS: Basics of Navigation, Localization and Odometry, Dead reckoning/ Scan Matching, Simultaneous Localization and Mapping - Hector SLAM - Cartographer, Particle filter localization - Path planning - DWA planner, TEB planner - Obstacle avoidance - PID algorithm - Robot arm Robot path planning and trajectory control using ROS.

Total: 15 Hours

Reference(s)

1. Morgan Quigley, Brian Gerkey, William D. Smart, "Programming Robots with ROS", O'Reilly Media, Inc., 2015.
2. Wyatt Newman “A Systematic Approach to Learning Robot Programming with ROS”, CRC press, 1st Edition, 2017.
3. YoonSeok Pyo, HanCheol Cho, RyuWoon Jung, TaeHoon Lim “ROS Robot Programming” , ROBOTIS Co., Ltd, 2018.
4. Damith Herath, David St-Onge “ Foundations of Robotics: A Multidisciplinary Approach with Python and ROS”, Springer, 2022.

Expert detail

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22ME0XD VEHICLE MODELLING USING CARMAKER 1 0 0 1

Course Objectives

- This course provides an in-depth exploration of IPG CarMaker, a simulation tool widely used in the automotive industry for vehicle dynamics analysis and control system development.
- Students will gain hands-on experience with CarMaker, focusing on vehicle dynamics, suspension control and Powertrain.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply CarMaker software to configure vehicle models, including body assembly and coordinate systems, for simulating longitudinal and lateral vehicle dynamics.
2. Analyze suspension, powertrain, and ADAS components using CarMaker tools to evaluate vehicle behavior and control strategies through hands-on simulations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	2	-	-	-	-	-	-	1	2	-	-
2	2	2	2	-	2	-	-	-	-	-	-	1	2	-	-

15 Hours

General Overview of CarMaker-Vehicle Model in CarMaker-The Vehicle Data Set Generator - CarMaker Coordinate Systems -Vehicle Body Assembly Configuration-Basic Vehicle Dynamics - Longitudinal Dynamics in CarMaker-Lateral Dynamics in CarMaker-Hands-on exercises Suspension Components: Springs, Dampers, Buffers, Stabilizers -Suspension Kinematics-Wheel Bearings -IPG Kinematics -Powertrain Drive Sources -Powertrain Driveline -Powertrain Control Units -Powertrain Power Supply -Vehicle Control -ADAS Application- Hands-on exercises

Total: 15 Hours

Reference(s)

1. Fundamentals of Vehicle Dynamics, Revised Edition R-506Author: Thomas Gillespie Publisher: SAE International Specs: Published by SAE International with a Product Code of R-506, ISBN of 978-1-4686-0176-3,
2. IPGAutomotiveGmbH – www.ipg-automotive.comAll rights reserved. Fail Safe Tester, IPG-Car,Ipg-Control,Ipg-Driver,Ipg-Engine,Ipg-Graph,Ipg-Kinematics,Ipg-Lock,Ipg-Motorcycle,Ipg-Movie,Ipg-Road,Ipg-Roadda-Ta, Ipg-Tire, Ipg-Trailer, Ipg-Truck 1999 - 2006
3. 3.IPG - CarMaker Reference ManualOriginal Title:IPG_CarMaker Reference Manual Uploaded bystuarnt Date uploadedon Jul 30, 2009 Description: IPG_CarMakerFull description

Expert detail

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22ME0XE AUTOPILOT AND GUIDANCE CONTROL FOR UNMANNED VEHICLES

1 0 0 1

Course Objectives

- Understand the principles of autopilot and guidance control for unmanned vehicles.
- Apply autopilot and guidance control techniques to unmanned vehicles.
- Design and implement autopilot and guidance control systems for unmanned vehicles.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Understand the principles, types, and applications of autopilot and guidance control systems in unmanned vehicles.
2. Design and evaluate autopilot and guidance control systems by integrating system architecture, software, and hardware components.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	1	2	1	-	-	-	2	-	-	2	2	2
2	3	3	3	3	3	2	-	-	-	3	2	2	3	2	3

Design And Implementation of Autopilot and Guidance Control Systems 15 Hours

Autopilot and guidance control, Types of autopilot and guidance control systems. Principles of operation of autopilot and guidance control systems. Application of autopilot and guidance control to unmanned vehicles. Application of autopilot and guidance control to unmanned vehicles. System requirements, System architecture, Software design, Hardware design. Testing and evaluation of autopilot and guidance control systems

Total: 15 Hours

Reference(s)

1. Flight Control Systems Practical Issues in Design and Implementation , Roger Pratt, Institution of Electrical Engineers, 2000.
2. Autonomous Underwater Vehicles: Modeling, Control Design and Simulation, Sabiha Wadoo (Author), Pushkin Kachroo.CRC Press; 1st edition (19 December 2017).
3. Underwater Vehicles: Design and Applications, GEORGE M. ROMAN, Nova Science Publishers, Inc. 2021.
4. Control of Ships and Underwater Vehicles: Design for Underactuated and Nonlinear Marine Systems, Sabiha Wadoo, Pushkin Kachroo, Springer; 2009th edition. 2021.
5. Advances in Unmanned Marine Vehicles, Robert Sutton, G. N. Roberts, Institution of Engineering and Technology, 2006

Expert detail

Mr. P, Sakthivel Associate firmware developer, Rently, Coimbatore.

22ME0XF DIGITAL ENERGY SYSTEMS 1 0 0 1

Course Objectives (CO)

- To understand the concepts and principles of digital energy systems.
- To explore the role of data analytics in optimizing energy generation, distribution, and consumption.
- To learn about IoT applications and sensor networks for energy monitoring and control.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply concepts of transactive energy, blockchain, and data ownership to the design and operation of digital power systems.
2. Implement machine learning techniques such as regression models and reinforcement learning to forecast and control energy systems.
3. Analyze cybersecurity challenges in digital energy networks and evaluate the impact of cyber-attacks on grid performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-

15 Hours

Digital Transformation of the Energy System-Trans active energy, Block chain, Data ownership in the digital power system, Computational Methods for Energy Networks-grid planning., Decision Support in Integrated Energy Systems, AI-Based Data and Machine Learning Approaches-Forecasting with regression models, Dynamic security assessment, Surrogate modelling, Learning control actions with reinforcement learning, Cybersecurity of Digital Energy Systems-impact of cyber-attacks on the power grid, hands-on experience with the programming, optimal scheduling problem.

Total: 15 Hours

References

1. Digital Energy: Intelligent Energy Systems and Technologies" by Andreas Sumper, Álvaro Gomis-Bellmunt, and Francisco D. Bianchi.
2. Smart Grid: Integrating Renewable, Distributed & Efficient Energy" by Fereidoon P. Sioshansi
3. "Block chain for Business" by Jai Singh Arun and Jerry Cuomo
4. Research papers from relevant journals (e.g., IEEE Transactions on Smart Grid, Applied Energy)

Expert detail

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22ME0XG ENERGY EFFICIENT BUILDINGS 1 0 0 1

Course Objectives

- To understand the principles of building energy efficiency.
- To evaluate building energy performance.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply knowledge of building energy consumption trends and influencing factors to evaluate the environmental and economic impact of energy-inefficient buildings.
2. Analyze the role of building envelope elements such as thermal insulation, air sealing, fenestration, and passive design in reducing energy demand and improving HVAC efficiency.
3. Investigate building energy performance through simulation-based analysis of HVAC components and conduct a mock energy audit to recommend practical energy-saving improvements.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
3	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-

Energy Efficient Buildings **20 Hours**

Building energy consumption trends, factors influencing energy use, and the environmental and economic impacts of energy-inefficient buildings. Measurement of building Energy consumption. Importance of building envelope, thermal insulation, air sealing, fenestration, and passive design strategies for reducing energy demand. Types of HVAC systems, efficiency considerations, control strategies, and energy-saving technologies. Analyzing the operation and efficiency of different HVAC components using simulation software. Hands on training on conducting a mock energy audit of a designated building space and presenting recommendations for improvement.

Total: 20 Hours

References

1. Building Energy Efficiency: A Handbook for Architects and Engineers by D. Crawley (McGraw-Hill Education, 2005).
2. Green Building Handbook: Volume 1: A Guide to Building Green Homes by F. S. Turner (Island Press, 2012).
3. Energy Efficiency in Buildings: Assessment and Optimization by M. M. Ahmed (Elsevier, 2016).
4. ASHRAE Handbook: Fundamentals (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Published annually).
5. International Energy Agency - Buildings and Construction: https://www.iea.org/energy-system/buildings
6. Lawrence Berkeley National Laboratory - Buildings & Indoor Environment Department: https://indoor.lbl.gov/

Expert detail

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22ME0XH DESIGN CONSIDERATIONS FOR 3D PRINTING 1 0 0 1

Course Objectives

- To familiarize the students with support structures, overhangs, and orientation optimization techniques for 3D printing.
- To introduce the students to geometric considerations and constraints unique to 3D printing technology.
- To identify the key components skills to design 3D printable objects that meet functional requirements and quality standards.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Analyze the designs by exploring geometric considerations and addressing constraints specific to 3D printing technology."
2. Apply onboard diagnostics (OBD) systems in monitoring and diagnosing engine and vehicle electronic faults
3. Infer the role of engine electronics in influencing vehicle performance, fuel efficiency, and emission control for system-level assessment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	-
2	3	2	-	-	3	2	3	-	-	-	-	-	3	2	-
3	2	3	-	-	-	-	-	2	-	-	-	-	3	2	-

Design Considerations for 3D Printing **15 Hours**

Design principles for 3D printing. Geometric considerations for 3D printing. Support structures and overhangs. Design of Support system - Support structures and overhangs. Wall thickness and feature resolution. Orientation and build direction optimization. Material considerations in design. Functional Requirements & Case studies - Design for functional requirements. Design for post-processing and finishing. Case studies and practical examples.

Total: 15 Hours

References

1. "3D Printing: A Practical Guide for Librarians" by Saroj Kumar Patel (Publisher: Ess Ess Publications)
2. "Additive Manufacturing: Principles, Processes and Practices" by K. K. Chawla and S. S. Dhami (Publisher: IK International Publishing House)
3. The 3D Printing Handbook: Technologies, Design and Applications" by Ben Redwood, Filemon Schöffer, and Brian Garret.

Expert detail

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22ME0XI SMART MATERIALS FOR ENERGY STORAGE 1 0 0 1

Course Objectives

- To understand the fundamentals of key smart materials for energy applications.
- To design, analyse and propose solutions for energy harvesting, conversion, or storage using smart materials.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)

1. Apply fundamental concepts of smart materials in the context of energy storage technologies.
2. Analyze the electrochemical behavior and energy density performance of materials used in batteries, supercapacitors, and hybrid systems.
3. Interpret results from material characterization techniques and propose performance-improving modifications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	2	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	2	-	-	-	-	-	-	-	2	-
3	2	2	-	-	-	2	-	-	-	-	-	-	-	1	-

Smart Materials for Energy Storage 20 Hours

Introduction to Smart Materials-Classification, Fundamentals, properties, different fabrication techniques and application of Piezoelectric Materials, Thermoelectric Materials, Shape Memory Alloys and other Smart Materials. Piezoelectricity: direct and converse effects- Properties and applications of various piezoelectric materials (ceramics, polymers) - Energy harvesting using piezoelectric materials. Measure output voltage and power generated by the device- calculate energy conversion efficiency and analyze performance parameters. Hands-on experience with basic characterization techniques (e.g., XRD, SEM, electrical impedance spectroscopy)

Total 20 Hours

References

1. Smart Materials for Energy, Communications and Security by L. Bih, D. Mezzane, A. Nadiri, H. Bih, M. Mansori, M. Amalhay (Springer, 2012).
2. Smart Materials and Devices for Energy Harvesting by D. Davino (MDPI, 2020).
3. Functional Materials for Sustainable Energy Applications by A. R. Barron (John Wiley & Sons, 2010).
4. Piezoelectric and Electroactive Materials: Characterization and Modeling by K. L. Komylowski (CRC Press, 2016).
5. Thermoelectric Nanomaterials by K. Koumoto, I. Terasaki, T. Tani (Springer, 2013).
6. Shape Memory Alloys: Fundamentals and Applications by K. Otsuka, C. M. Wayman (Cambridge University Press, 2002).
7. Functional Materials: Design, Properties, and Applications by S. M. Hong, J. Lee (Springer, 2013).
8. Handbook of Smart Materials by G. Kickelbinder (Wiley-VCH, 2014).

Expert detail

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22ME0XJ CFD ANALYSIS IN ENERGY SYSTEM 1 0 0 1

Course Objectives

- To provide students with a comprehensive understanding of the principles of CFD and its application to nonreactive energy systems.
- Apply CFD techniques to design and optimize nonreactive energy systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply governing equations and discretization methods to develop CFD models for simulating fluid flow and heat transfer in energy systems.
2. Analyze and optimize thermal and renewable energy system performance through advanced CFD simulations using ANSYS Fluent, Open FOAM, and MATLAB frameworks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
2	2	2	2	-	2	-	-	-	-	-	-	-	-	-	2

Computational Fluid Dynamics for Nonreactive Energy System 15 Hours

Introduction CFD, governing equations of fluid flow and heat transfer, Discretization methods (finite difference, finite volume, finite element), Introduction to CFD software (e.g., ANSYS Fluent, Open FOAM) Boundary conditions for heat transfer simulations, Heat transfer coefficients and correlations, Reynolds-averaged Naiver-Stokes (RANS) equations, Flow through pipes and ducts, Flow over surfaces (boundary layers), Flow around obstacles (bluff body flows) Large Eddy Simulation (LES), Analysis of heat exchanger performance using CFD, Optimization of thermal systems CFD modelling of wind turbines, Solar energy systems and thermal storage, Hydrodynamics of wave and tidal energy converters. Hand on training - CFD coding, simple solvers and turbulence models in MATLAB and Open FOAM framework, advanced user of ANSYS Fluent and pre/post-processing utilities, advanced meshing in ANSA, simulating and solving advanced CFD problems in different fields using CONVERGE, problem-solving in Renewable Energy system.

Total: 15 Hours

References

1. Computational Fluid Dynamics: Principles and Applications" by Jiri Blazek.
2. Computational Fluid Dynamics for Engineers" by Tuncer Cebeci and Jian P. Shao.
3. Heat Transfer" by Yunus A. Çengel and Afshin J. Ghajar.

Expert Details

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22ME0XK CONTROL SYSTEM DESIGN IN UNDERWATER VEHICLES 1 0 0 1

Course Objectives

- To apply fundamental engineering principles to underwater robotics.
- To evaluate different types of control systems for underwater vehicles.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Demonstrate knowledge of various underwater robots and their applications.
2. Design a control algorithm for an underwater vehicle.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	2	2	2	-	2	-	-	-	-	-	-	-	2	-	-

Control System design in Underwater Vehicles 16 Hours

Introduction: Robotics in Water - Basics Representation of Underwater Robot - Types and classification of underwater robotics differentiating aerial and underwater robotics why it is called a perfect engineering product overview about environmental factors affecting object in water. Control System and Manipulator- Control System and Types of Control Systems in Underwater Robotics Sensors Connected with the Underwater Robotics Introduction to Underwater Manipulators Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles. Autonomous Underwater Systems: Introduction to AUVS - Development of AUVs, ROV in Market - Case Study on AUV Control System Basics - Case Study on Subsea Manipulator - Case Study on Technologies Used.

Total: 16 Hours

References

1. Gianluca Antonelli, "Underwater Robots", Springer, 2014.
2. Pushkin Kachroo and Sabiha Wadoo, “Autonomous underwater vehicles: Autonomous Underwater Vehicles: Modeling, Control Design and Simulation, Taylor and Francis, 2017.

Expert detail

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22ME0XL DESIGNING AND MANUFACTURING OF MOULD AND DIE OF VARIOUS INDUSTRIAL COMPONENTS 1 0 0 1

Course Objectives

- Identify the various Industrial materials used in Automotive, Home Appliance and Medical fields.
- Understand the basic design of mould & die using software.
- Apply the CNC programming for complex design using CAM software.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques.

Course Outcomes (COs)

1. Apply plastics and mould design concepts to develop components for industrial moulding applications.
2. Design moulds using runner, gate, cooling, and shrinkage parameters with CAM software for CNC machining.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	1	1	-	-	-	-	-	-	3
2	2	2	3	2	2	-	-	1	-	-	-	-	-	-	3

Designing and Manufacturing of Mould and Die of various Industrial Components 15 Hours

Introduction to Injection Moulding - Fundamentals of plastics mould design - Plastics in the mould industry – properties of plastics – application – processing – Injection moulding - - Hand Injection moulds – Terminology - mould materials Feed system – Runner – types of runner – Runner die calculation – Gate – types of gates - – Parting surface – venting – shrinkage – values of shrinkage – Factors governing shrinkage– temperature control – cooling – mould cooling calculation – side core and side cavity - Compression moulding – applications – temperature and pressure ranges – basic types of compression moulds – Transfer moulding – application – advantages and limitations – types of transfer mould – pot type and plunger type – Introduction to CAM programming – 2 and 3-Axis machine programming in CAM – Verification of model – Cycle time calculations – Program generation using CAM software for CNC machines.

Total: 15 Hours

References

1. R. G. W. Pye, Injection Mould Design, East-West Press, 4th Edition, 2022.
2. P. C. Sharma, A Text Book of Production Engineering, S. Chand, 2008.
3. Serope Kalpakjian and Stven R. Schmid, Manufacturing Engineering and Technology, Pearson, 8th Edition, 2020.
4. Sanjay K. Nayak, Pratap Chandra Padhi and Y. Hidayathullah, Fundamentals of Plastics Mould Design, Tata McGraw Hill Education Private Limited, 2012.

Expert detail

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22ME0XM GEARBOX DESIGN AND INTRODUCTION TO PLANETARY GEARBOX **1 0 0 1**

Course Objectives
- Understand Fundamental Principles of Gearbox Design.
- Explore Gearbox Manufacturing and Material Selection.
- Apply Machine Design Concepts to Gearbox Components.

Programme Outcomes (POs)
PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2: Apply knowledge acquired in mechanical engineering with an analytical/computational tools to design, analyze and provide solutions for real world applications.

Course Outcomes (COs)
1. Design and analyze gearbox systems, including gear ratios, torque transmission, and load distribution for optimal performance.
2. Develop solutions to complex gearbox design issues by applying innovative methods to reduce noise, vibration, and enhance performance.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	-	-	-	-	-	-	-	-	-	3	2	-
2	2	2	3	2	-	-	-	-	-	-	-	-	3	2	-

Generative design for structure **15 Hours**

Gears-Introduction, type of gear drives, tooth profile, loads on gear tooth and safety, bearing and seal selection, lubrication system, material, heat treatment and gear engineering drawing format. Planetary gearbox- Introduction, different planetary gear arrangement, planet bearing load and life calculation, gearbox installation, maintenance, Practical applications.

Total: 15 Hours

References

1. Handbook of Gear Design, by Gitin M Maitra section edition, Tata McGraw Hill Eduction private Limited.
2. Gear Drive system-design and its application, by Peter Lynwander, Marcel Deckker.
3. Dudley’s Gear Handbook, The design, manufacture, and Application of Gears by Dennis P. Townsend, Tata McGraw Hill edition.

Expert detail

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22OAG01 RAINWATER HARVESTING TECHNIQUES 3 0 0 3

Course Objectives

- To enhance the awareness about water resources management and conservation
- To acquire knowledge about water harvesting techniques and their implementation
- To practice the design aspects of sustainable rainwater harvesting solutions for communities

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Assess the global and Indian water resource patterns and assess challenges in scarcity, pollution, and governance to formulate sustainable management strategies.
2. Demonstrate the principles of rural and urban water harvesting to design and develop watershed-based conservation systems with community participation.
3. Formulate surface runoff harvesting plans by analysing site conditions, computing runoff, and developing cost-effective storage structures.
4. Evaluate flood water harvesting methods and design efficient diversion and control structures to mitigate flood and drought impacts.
5. Develop groundwater harvesting and artificial recharge systems by interpreting aquifer characteristics and applying appropriate subsurface techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	2	-	-	-	-	-	-	-	2
2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	3	-	-	-	2	-	-	-	-	-	-	-	2
4	2	2		3	-	-	2	-	-	-	-	-	-	-	2
5	2	2	3	-	-	-	2	-	-	-	-	-	-	-	2

UNIT I **8 Hours**
WATER RESOURCES
Global water distribution – primary and secondary sources of water – technical, social and cultural aspects; Global challenges in water and climate – water scarcity – water pollution – Indian scenario; Water resources management – public participation – integrated approach; Water governance – water sharing plans – policy, schemes and concerns

UNIT II **10 Hours**
WATER CONSERVATION CHALLENGES
Principles of water harvesting for rural and urban – collection at micro and macro levels, flow control, storage and uses; Rainwater harvesting systems – traditional and contemporary – groundwater recharge; Water resources inventory – site analysis – database collection – water allocation principles based on demand and supply; Traditional water harvesting systems – practices in India – references in old texts – reasons for their deterioration – way forward; Watershed-based approach – project planning at micro and macro levels – community participation – rain centres.

UNIT III **9 Hours**
SURFACE RUNOFF HARVESTING
Short-term and micro-level harvesting techniques for runoff – terracing and bunding – rock and ground catchments; Long-term and macro-level harvesting techniques for runoff – farm ponds – percolation ponds and nala bunds; Design considerations – site selection – selection of runoff coefficients – computation of rainwater runoff volume – hydrograph analysis – cost estimation; Design of storage structures – storage capacity – selection of component – methods of construction.

UNIT IV **9 Hours**
FLOOD WATER HARVESTING
Floods – causes of urban floods and droughts – characteristics of water spread – impacts; Flood water harvesting – permeable rock dams – water spreading bunds – flood control reservoir; Design considerations – computation of flood water quantity; Trenching and Diversion Structures – types – site selection – design criteria – most economic section – design consideration of ditch system

UNIT V **9 Hours**
GROUNDWATER HARVESTING
Rooftop rainwater harvesting – recharge pit – recharge trench – tube well – recharge well; artificial recharge – gully plug – dug well – percolation tank – nala bunds – recharge shaft; Groundwater harvesting – aquifer characteristics – subsurface techniques – infiltration wells – recharge wells – groundwater dams; Design of drainage system – types – design criteria – filter design – causes of failure

Total: 45 Hours

Reference(s)

1. Theib YO, Dieter P, Ahmed YH, Rainwater Harvesting for Agriculture in the Dry Areas, CRC Press, Taylor and Francis Group, London, 2012.
2. Lancaster, Brad. Rainwater Harvesting for Drylands and Beyond, Volume 1, 3rd edition, Rainsource Press. 2019.
3. Das M, Open Channel Flow, Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
4. Michael AM, Ojha TP, Principles of Agricultural Engineering, Volume II, 4th Edition, Jain Brothers, New Delhi, 2003.
5. Suresh R, Soil and Water Conservation Engineering, Standard Publisher Distributors, New Delhi, 2014.
6. Singh G, Venkataramanan C, Sastry G, Joshi BP, Manual of Soil and Water Conservation Practices, CSWCR&TI, Dehradun, 1990

22OCE02 COST MANAGEMENT OF ENGINEERING PROJECTS 3 0 0 3

Course Objectives

- To introduce fundamental quantitative techniques, including linear programming, PERT/CPM, and optimization models, for effective cost management.
- To develop analytical skills for solving transportation and assignment problems to enhance resource allocation and cost efficiency.
- To apply learning curve theory in project planning and cost estimation to improve productivity and financial forecasting.
- To enable the use of quantitative decision-making tools for optimizing project scheduling, budgeting, and overall cost control.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Interpret diverse costing concepts and assess their relevance in decision-making to implement operational control through structured databases.
2. Illustrate project life cycle stages and formulate execution strategies by integrating technical and non-technical aspects for cost efficiency.
3. Compare marginal and absorption costing methods, and develop cost-control frameworks using break-even and life cycle costing for informed project decisions.
4. Design and integrate modern costing approaches and budgetary control systems to optimise resource allocation and performance measurement.
5. Develop quantitative techniques and advanced cost management tools to devise data-driven solutions for operational and strategic decision-making.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	2	-	-	-	-	-	-	2	-	-	-	2
2	3	2	-	-	-	-	-	-	-	-	2	-	-	-	2
3	2	2	3	-	-	-	-	-	-	-	2	-	-	-	2
4	2	2	3	-	-	-	-	-	-	-	2	-	-	-	2
5	2	2	3	-	-	-	-	-	-	-	2	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO COSTING CONCEPTS

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control

UNIT II **9 Hours**

INTRODUCTION TO PROJECT MANAGEMENT

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

UNIT III **9 Hours**

INHERITANCE PROJECT EXECUTION AND COSTING CONCEPTS

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle costing..

UNIT IV **9 Hours**

COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V **9 Hours**

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost

Total: 45 Hours

Reference(s)

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.
3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011.
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

22OCB01 INTERNATIONAL BUSINESS MANAGEMENT 3 0 0 3

Course Objectives

- To enable the students to understand the fundamentals of international business
- To provide competence to the students on making international business decisions
- To enable the students to understand the financial and promotional assistance available for exporters

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply fundamental concepts and trade theories to assess differences and drivers between domestic and international business contexts.
2. Examine globalization’s implications and compare trade barriers, integration forms, and roles of WTO and IMF in shaping business environments.
3. Formulate market, production, marketing, and HR strategies to develop competitive multinational business plans.
4. Illustrate exchange rate determination theories and implement risk management techniques in foreign exchange operations.
5. Assess export risks, regulatory frameworks, and financing options, and integrate ethical principles into global trade practices.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	2	2	-	-	2	2	-	-	-	-	-	-	-	2
3	3	2	2		-	-	-	-	-	-	-	-	-	-	2
4	3	2	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	2	-	-	-	2	-	2	-	-	-	-	-	-	2

UNIT I **9 Hours**
INTRODUCTION
Definition, Drivers of International Business, Domestic Vs. International Business, Trade and Investment Theories: Interventionist Theories, Free Trade Theories, Theories Explaining Trade Patterns: PLC Theory, The Porter Diamond, Factor Mobility Theory

9 Hours
UNIT II
GLOBALIZATION
Globalization: Implications, Challenges - Protectionism: Tariff Barriers, Non-Tariff Barriers- Forms of Integration, Role of WTO and IMF in International Business, Economic, Political, Cultural and Technological Environments.

9 Hours
UNIT III
INTERNATIONAL BUSINESS STRATEGIES
Market Entry Strategies, Multinational Strategy, Production Strategy, Marketing Strategy, Human Resource Strategy

UNIT IV **9 Hours**
FOREIGN EXCHANGE
Foreign Exchange Market – Functions, Theories of Exchange Rate Determination, Exchange Rate Forecasting, Convertibility of Currency, Risks associated with Foreign Exchange

UNIT V **9 Hours**
EXPORTS AND ETHICS IN INTERNATIONAL BUSINESS
Exports – Risks, Management of Exports, Regulatory frameworks, Export financing, Countertrade, Ethics – Issues, Dilemma and Theory..

Total: 45 Hours

Reference(s)

1. John D Daniels, Lee H.Radebaugh, and Sullivan, “International Business”, New Delhi: Pearson Education, 2018.
2. Charles W L Hill and Arun Kumar Jain, “International Business”, New Delhi: Tata McGraw Hill, 2017.
3. Francis Cherunilam, “International Business”, New Delhi: Prentice Hall of India, 2020.
4. Simon Collinson, Rajneesh Narula, Alan M. Rugman, “International Business”, New Delhi: Pearson Education, 2020.
5. K.Aswathappa, “International Business”, New Delhi: Tata McGraw Hill, 2020.

22OCS01 OBJECT ORIENTED PROGRAMMING 3 0 0 3

Course Objectives

- Understand the concepts of Object-Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Interpret the characteristics and data types of C++ language through practical examples.
2. Develop C++ programs using classes and objects to solve real-world problems.
3. Construct C++ programs implementing operator overloading and inheritance to solve real-world problems.
4. Apply polymorphism and file stream concepts to implement effective C++ solutions for data-driven tasks.
5. Design C++ applications using templates and integrate exception handling to enhance software robustness.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	-	-	-	-	-	-	-	-	-	-	2
2	2	1	3	1	1	-	-	-	-	-	-	-	-	-	2
3	2	1	3	2	1	-	-	-	-	-	-	-	-	-	2
4	3	1	2	1	1	-	-	-	-	-	-	-	-	-	2
5	2	1	3	2	2	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**
INTRODUCTION
Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading. (sona)

UNIT II **9 Hours**
OBJECTS AND CLASSES
Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**
OPERATOR OVERLOADING AND INHERITANCE
Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **9 Hours**
POLYMORPHISM AND FILE STREAMS
Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **9 Hours**
TEMPLATES AND EXCEPTION HANDLING
Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

22OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Demonstrate the use of classes, objects, and control structures in Java to develop basic applications.
2. Construct Java applications using inheritance, packages, and exception handling to solve real-world problems.
3. Interpret Java I/O concepts to handle various input and output operations in structured Java programs.
4. Develop Java programs for performing string manipulation operations.
5. Design graphical user interfaces (GUI) using Java AWT to implement event handling and connect to databases.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	1	-	1	-	-	-	-	-	-	-	-	-	2
2	2	1	3	2	1	-	-	-	-	-	-	-	-	-	2
3	3	1	1	-	1	-	-	-	-	-	-	-	-	-	2
4	2	1	3	1	1	-	-	-	-	-	-	-	-	-	2
5	2	1	3	3	2	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

22OCS03 KNOWLEDGE DISCOVERY IN DATABASES 3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Interpret the components of Data Warehousing architecture and the business analysis process with practical examples.
2. Assess the process of Data Mining and demonstrate preprocessing techniques for effective data cleansing in real-world datasets.
3. Apply association rule mining techniques to discover frequent patterns and correlations from structured data.
4. Analyze classification and clustering algorithms to solve high-dimensional data problems using performance metrics and validation techniques.
5. Illustrate data mining techniques for extracting insights from complex data objects such as images, text, and graphs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PO2	PSO3
1	3	1	-	-	1	-	-	-	-	-	-	-	-	-	2
2	3	1	-	-	1	-	-	-	-	-	-	-	-	-	2
3	3	1	-	1	2	-	-	-	-	-	-	-	-	-	2
4	2	1	-	3	2	-	-	-	-	-	-	-	-	-	2
5	3	1	-	1	2	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS-Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **8 Hours**

INTRODUCTION TO DATA MINING

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**

ASSOCIATION RULE MINING

Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**

CLASSIFICATION AND CLUSTERING

Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k- medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**

DATA MINING APPLICATIONS

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining -Application and trends in data mining - Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

22OCS04 E LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Interpret the foundational concepts and principles of e-learning through case-based examples.
2. Illustrate technology-mediated communication strategies used in e-learning environments by evaluating tools and platforms.
3. Demonstrate the process of content creation and learning management in different e-learning systems.
4. Analyze teaching and learning strategies used in e-learning environments to identify their effectiveness.
5. Assess real-time applications of e-learning to determine their impact on learner engagement and outcomes.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	2
2	3	1	-	1	1	-	-	-	-	-	-	-	-	-	2
3	3	1	1	1	1	-	-	-	-	-	-	-	-	-	2
4	2	3	-	2	2	-	-	-	-	-	-	-	-	-	2
5	3	2	-	2	2	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**
TECHNOLOGIES
Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**
MANAGEMENT
Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS
Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**
APPLICATIONS
Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

3 0 0 3

22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Demonstrate the concepts, techniques, and real-time applications of text mining using domain-specific datasets.
2. Interpret the process of content and sentiment analysis in analyzing user-generated data for opinion mining.
3. Illustrate web analytics using suitable models and frameworks for user behavior analysis and reporting.
4. Implement social network analytics techniques by applying centrality measures and graph-based models to real-world networks.
5. Analyze social media data to derive actionable insights through trend analysis and influence detection techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	-	-	-	-	-	-	2
2	3	1	-	-	2	-	-	-	-	-	-	-	-	-	2
3	3	1	-	1	3	-	-	-	-	-	-	-	-	-	2
4	3	1	-	1	3	-	-	-	-	-	-	-	-	-	2
5	2	3	-	3	3	-	-	-	-	-	-	-	-	-	2

UNIT I **7 Hours**

TEXT MINING

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**
METHODS
Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**
WEB ANALYTICS
Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**
SOCIAL NETWORK ANALYTICS
Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**
SOCIAL MEDIA ANALYTICS
Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

22OIT01 DATA STRUCTURES 3 0 0 3

Course Objectives

- To understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures
- To analyze the performance of algorithms using time and space complexity.
- To understand the behavior of Linear and Non-Linear data structures
- To choose the appropriate data structures for a specified application
- To write programs in C++ to solve problems using various data structures

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Illustrate fundamental data structures and analyze their performance using time and space complexity.
2. Apply searching and sorting algorithms to retrieve and organize data efficiently.
3. Assess the linear data structures to store and manage data effectively.
4. Implement tree-based data structures and heaps to organize and access hierarchical data.
5. Analyze graph algorithms to evaluate their efficiency in solving connectivity problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	2	-	-	-	-	-	-	-	-	-	2
2	3	2	2	-	2	-	2	-	-	-	-	-	-	-	2
3	3	2	2	-	2	-	2	-	-	-	-	-	-	-	2
4	3	2	2	-	2	-	2	-	-	-	-	-	-	-	2
5	2	2	2	3	2	-	2	-	-	-	-	-	-	-	2

UNIT I **8 Hours**

INTRODUCTION

Introduction to data structures-types of data structures- Pseudo code - Abstract data types - ADT Implementations performance analysis- time complexity and space complexity- basics of OOPS concepts.

UNIT II **9 Hours**

SORTING AND SEARCHING TECHNIQUES

Searching methods: Linear and binary search methods, Sorting techniques: Insertion Sort - Selection Sort - Bubble Sort - Merge sort - Quick sort

UNIT III **11 Hours**

LINEAR DATA STRUCTURES

Stack operation - Stack ADT - Applications of stack - Queues operations - Queue ADT - Queue applications – Linked List - Circular - Doubly linked list..

UNIT IV **11 Hours**

TREE

Basic Tree concepts - Binary Trees - Tree Traversals - Binary Search Trees – B Tree - Heap concepts - Heap ADT

UNIT V **6 Hours**

GRAPHS

Introduction – types of graph- Shortest Path Algorithms: Unweighted Shortest Paths - Dijkstra's Algorithm. Minimum Spanning Tree: Prim's Algorithm - Kruskal's Algorithm- graph search methods DFS, BFS

Total: 45 Hours

Reference(s)

1. A Abirami, Priya R L , Advanced Data Structures and Algorithms , BPB publisher, 2023 March.
2. Data Structures using C++, Special Edition-MRCET, Tata McGraw-Hill Publishers 2017.
3. Data structures and Algorithms in C++, Michael T.Goodrich, R.Tamassia and Mount, Wiley student edition, John Wiley and Sons, 2011.
4. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education. Ltd., Second Edition, 2013.
5. D.S. Malik, Data Structures Using C++, Second Edition 2010

22OIT02 C++ PROGRAMMING 2 0 2 3

Course Objectives

- To understand the concept of Object-Oriented Programming
- To apply the Object-Oriented concepts to solve problems using C++

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Illustrate C++ programming constructs to develop structured and efficient program solutions.
2. Implement object-oriented programming to build modular and reusable C++ programs.
3. Develop reusable and extensible C++ programs using operator overloading and inheritance.
4. Apply polymorphism and advanced object-oriented features in C++ for flexible software design.
5. Demonstrate templates and exception handling to develop generic and robust C++ programs.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	2	2	-	-	-	-	2
2	3	2	-	-	2	-	-	-	2	2	-	-	-	-	2
3	1	3	3	-	2	-	-	-	2	2	-	-	-	-	2
4	3	2	1	-	2	-	-	-	2	2	-	-	-	-	2
5	3	2	2	-	2	-	-	-	2	2	-	-	-	-	2

UNIT I 5 Hours

BASICS OF C++ PROGRAMMING

C++ Program Structure, Character Set and Tokens, Data Type, Type Conversion, Preprocessor Directives, Namespace, Input/output Streams and Manipulators, Dynamic Memory Allocation with new and delete, Control Statements. Functions: Function Overloading, Inline Functions, Default Argument, Pass by Reference, Return by Reference, Scope and Storage Class. Pointers: Pointer variables declaration & initialization, Operators in pointers, Pointers and Arrays, Pointer and Function

UNIT II **6 Hours**

CLASSES & OBJECTS

A Simple Class and Object, accessing members of class, Initialization of class objects: (Constructor, Destructor), Default Constructor, Parameterized Constructor, Copy Constructor, The Default Copy Constructor, Objects as Function Arguments, Returning Objects from Functions, Structures and Classes, Memory allocation for Objects, Static members, Member functions defined outside the class.

UNIT III **7 Hours**

OPERATOR OVERLOADING & INHERITANCE

Fundamental of operator overloading, Restriction on operator overloading, Operator functions as a class member, Overloading unary and binary operator, Introduction to inheritance, Derived Class and Base Class, Access Specifiers (private, protected, and public), Types of inheritance.

UNIT IV **6 Hours**

VIRTUAL FUNCTION & POLYMORPHISM

Concept of Virtual functions, Late Binding, Abstract class and pure virtual functions, Virtual Destructors, Virtual base class, Friend function and Static function, Assignment and copy initialization, Copy constructor, This pointer, Concrete classes, Polymorphism and its roles

UNIT V **6 Hours**

FUNCTION TEMPLATES AND EXCEPTION HANDLING

Function templates, Function templates with multiple arguments, Class templates, templates and inheritance, Exceptional Handling (Try, throw and catch), Use of exceptional handling.

EXPERIMENT 1 — 3 Hours

Introduction to Object Oriented Programming- Classes and Objects

EXPERIMENT 2 — 5 Hours

Programs using Constructor, Destructor

EXPERIMENT 3 — 4 Hours

Programs on operator overloading

EXPERIMENT 4 — 5 Hours

Programs on Inheritance

EXPERIMENT 5 — 3 Hours

Programs on Virtual Function

EXPERIMENT 6 — 3 Hours

Programs on Friend Function

EXPERIMENT 7 — 3 Hours

Programs on exception handling

EXPERIMENT 8 — 4 Hours

Programs on Function and Class Templates

Total: 60 Hours

Reference(s)

1. E Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2011.
2. Robert Lafore, Object Oriented Programming in C++, Galgotia Publication, 2010.
3. B Trivedi, Programming with ANSI C++, Oxford University Press, 2010
4. H M Deitel and P J Deitel, C++ How to Program, Seventh Edition, Prentice Hall, 2010
5. K R Venugopal, Rajkumar and T Ravishankar, Mastering C++, Tata McGraw Hill Publishing, New Delhi, 2010

22OIT03 PROGRAMMING IN JAVA 2 0 2 3

Course Objectives

- To understand the concept of Object-Oriented Programming
- To develop console applications using Java.
- To develop GUI applications using Java library classes.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Assess OOP principles and core Java features to build structured and modular programs.
2. Implement inheritance and interfaces to develop reusable and flexible object-oriented applications.
3. Demonstrate exception handling and file I/O operations in Java to build robust and reliable applications.
4. Develop efficient and scalable Java applications using multithreading and generic programming concepts.
5. Design interactive GUIs in Java using AWT, Swing, graphics, and event handling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	2	-	-	-	2	2	-	-	-	-	2
2	3	2	-	-	2	-	-	-	2	2	-	-	-	-	2
3	3	2	2	-	2	-	-	-	2	2	-	-	-	-	2
4	2	2	3	-	2	-	-	-	2	2	-	-	-	-	2
5	2	2	3	-	2	-	-	-	2	2	-	-	-	-	2

UNIT I **6 Hours**

INTRODUCTION TO OOP AND JAVA FUNDAMENTALS

Object Oriented Programming - Abstraction - objects and classes - Encapsulation- Inheritance - Polymorphism- OOP in Java - Characteristics of Java - The Java Environment - Java Source File - Structure - Compilation. Fundamental Programming Structures in Java - Defining classes in Java - constructors, methods - access specifiers - static members -Comments, Data Types, Variables, Operators, Control Flow, Arrays, Packages - JavaDoc comments.

UNIT II **6 Hours**

INHERITANCE AND INTERFACES

Inheritance - Super classes- sub classes –Protected members - constructors in sub classes- the Object class - abstract classes and methods- final methods and classes - Interfaces -defining an interface, implementing interface, differences between classes and interfaces and extending interfaces
-Object cloning -inner classes, Array Lists - Strings

UNIT III **6 Hours**

EXCEPTION HANDLING AND I/O

Exceptions - exception hierarchy - throwing and catching exceptions - built-in exceptions, creating own exceptions, Stack Trace Elements. Input / Output Basics - Streams - Byte streams and Character streams - Reading and Writing Console - Reading and Writing Files

UNIT IV **6 Hours**

MULTITHREADING AND GENERIC PROGRAMMING

Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming - Generic classes - generic methods - Bounded Types - Restrictions and Limitations
.

UNIT V **6 Hours**

EVENT DRIVEN PROGRAMMING

Graphics programming - Frame - Components -working with 2D shapes - Using color, fonts, and images - Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy - Introduction to Swing - layout management - Swing Components - Text Fields, Text Areas – Button s- Check Boxes - Radio Buttons - Lists- choices- Scrollbars -Windows - Menus - Dialog Boxes.

EXPERIMENT 1 **4 Hours**

Introduction to Object Oriented Programming- Classes and Objects

EXPERIMENT 2 **5 Hours**

Programs using inheritance and polymorphism

EXPERIMENT 3 **5 Hours**

Programs on operator overloading.

EXPERIMENT 4 **5 Hours**

Programs on exception handling

EXPERIMENT 5 **5 Hours**

Programs on multi-threading in java

EXPERIMENT 6 **6 Hours**

Programs on java swing

Total: 60 Hours

Reference(s)

1. Herbert Schildt, Java: The Complete Reference, Eleventh Edition, McGraw-Hill Education, 2018.
2. D.T. Editorial Services, Java 8 Programming Black Book, second edition, Dreamtech Press,2015.
3. Vaskaran Sarcar, Interactive Object-Oriented Programming in Java, Second edition, Apress, 2019

22OIT04 FUNDAMENTALS OF DATABASE MANAGEMENT SYSTEMS 2 0 2 3

Course Objectives

- Understand functional components of the Database Management System
- Understand need for concurrency and transaction property
- Compare and contrast various indexing strategies in different database systems

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Asses the essential concepts and key issues involved in the design of a relational database
2. Apply the concepts of normalization and ER model to guarantee an efficient database
3. Analyze the concurrent execution of transaction process and various recoveries from failures
4. Formulate indexing and query optimization techniques for a database design
5. Evaluate the various advanced database systems for efficient data storage & NOSQL concepts.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	2	-	-	-	2	2	-	-	-	-	2
2	3	2	-	-	2	-	-	-	2	2	-	-	-	-	2
3	2	-	2	3	2	-	-	-	2	2	-	-	-	-	2
4	2	3	2	-	2	-	-	-	2	2	-	-	-	-	2
5	2	2	2	3	2	-	-	-	2	2	-	-	-	-	2

UNIT I **6 Hours**

RELATIONAL DATABASES

Purpose of Database System - Views of data - Data Models - Database System Architecture - Introduction to relational databases - Relational Model - Keys - Relational Algebra - SQL fundamentals - Advanced SQL features

UNIT Ii **6 Hours**

DATABASE DESIGN

Entity-Relationship model - E-R Diagrams - Enhanced-ER Model - ER-to-Relational Mapping – Functional Dependencies - First, Second, Third Normal Forms, - Boyce/Codd Normal Form-Multivalued Dependencies and Fourth Normal Form

UNIT III **6 Hours**

TRANSACTION

Transaction Concepts - ACID Properties - Schedules - Serializability - Concurrency Control -Need for Concurrency - Locking Protocols - Two-Phase Locking - Deadlock - Transaction Recovery - Save Points - Isolation Levels

UNIT IV **6 Hours**

FIRE AND QUERY PROCESSING

RAID - File Organization - Organization of Records in Files - Indexing and Hashing -Ordered Indices - Static Hashing - Dynamic Hashing - Query Processing Overview - Algorithms for SELECT and JOIN operations

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UNIT V **6 Hours**

ADVANCED DATABASES

Distributed Databases: Architecture, Data Storage, Transaction Processing - Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL, OQL - Graph Database

EXPERIMENT 1 3 Hours

Data Definition Commands, Data Manipulation Commands for inserting, deleting, updating and retrieving Tables with suitable examples.

EXPERIMENT 2 5 Hours

Implementation of different types of operators in SQL. - Arithmetic Operators - Logical Operators - Comparison Operator - Special Operator - Set Operation

EXPERIMENT 3 3 Hours

Database Querying - Simple queries, Nested queries, Sub queries & Joins

EXPERIMENT 4 3 Hours

Implement - Group By & having clause - Order by clause – Indexing

EXPERIMENT 5 4 Hours

Create a student database table currently stored as a single table. Normalize these structures to meet the 3NF requirements and draw ER model Diagram

EXPERIMENT 6 5 Hours

Implementation of Database Backup & Recovery commands, Rollback, Commit & Savepoint

EXPERIMENT 7 **5 Hours**

Develop database for a BOOK PUBLISHING COMPANY

Total: 60 Hours

Reference(s)

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System Concepts, Sixth Edition, Tata McGraw Hill, 2011.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Sixth Edition, Pearson Education, 2011.
3. C.J.Date, A.Kannan, S.Swamynathan, An Introduction to Database Systems, Eighth Edition, Pearson Education, 2006.
4. Raghu Ramakrishnan, Database Management Systems, Fourth Edition, McGraw-Hill College Publications, 2015.
5. G.K.Gupta,Database Management Systems, Tata McGraw Hill, 2011

22OEC01 BASICS OF ANALOG AND DIGITAL ELECTRONICS

3 0 0 3

Course Objectives

- Understand the working of diodes and transistors in electronic circuits.
- Understand the analog operational amplifier and its applications.
- Understand the implementation of combinational and sequential circuits in digital systems.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply semiconductor devices (diodes, transistors, FETs, MOSFETs) in rectifiers, regulators, and amplifiers and analyze their electrical characteristics for effective circuit operation.
2. Analyze the performance of operational amplifiers under various configurations (inverting, non-inverting, differential, integrator, differentiator) and justify their applications in analog signal processing.
3. Formulate optimized logic expressions with Karnaugh maps and integrate them into combinational circuit designs
4. Investigate the operation of sequential circuits including flip-flops, counters, and registers, and evaluate memory structures for digital system applications.
5. Evaluate the performance of A/D and D/A converters and classify them with respect to parameters such as resolution, accuracy, linearity, and conversion speed.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	2	2	2	-	-	-	-	-	-	-	-	-	-	2
5	2	2	2	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

SEMICONDUCTORS DEVICES

Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

UNIT II **9 Hours**

OPERATIONAL AMPLIFIERS: DC PERFORMANCE

The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

UNIT III **9 Hours**

DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS

Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws. Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

UNIT IV **9 Hours**

DIGITAL TECHNIQUES: SEQUENTIAL CIRCUITS

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

UNIT V **9 Hours**

DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS

Digital to Analog Converters : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches. Analog to Digital Converters: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

Total: 45 Hours

Reference(s)

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw-Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

22OEC02 MICROCONTROLLER PROGRAMMING 3 0 0 3

Course Objectives

- To understand the series of microcontrollers in terms of architecture, Programming and Interfacing.
- To impart knowledge on the development of assembly language programs.
- To study the programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers.
- To impart knowledge on the interfacing techniques of various PIC hardware.
- To learn the emerging trends in the design of advanced Microcontrollers.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply the components, architecture, and functionalities of 8051 microcontrollers in simple embedded applications
2. Develop assembly language programs on 8051 to implement timers, counters, and peripheral-based applications
3. Analyze the features, instruction set, and operational modes of PIC microcontrollers across different versions
4. Integrate peripherals such as ADC, DAC, sensors, and communication modules with PIC microcontrollers for application-oriented designs
5. Investigate the architecture, instruction sets, and programming models of ARM microcontrollers to address advanced embedded system applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	2
2	2	2	-	-	-	-	-	-	-	-	-	1	-	-	2
3	2	3	-	-	-	-	-	-	-	-	-	1	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	1	-	-	2
5	2	2	2	2	-	-	-	-	-	-	-	1	-	-	2

UNIT I **9 Hours**

8-BIT MICROCONTROLLER

Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

UNIT II **9 Hours**

8051 ALP AND APPLICATIONS

Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

UNIT III **9 Hours**

PIC MICROCONTROLLER

PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

UNIT IV **9 Hours**

PIC HARDWARE

Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

UNIT V **9 Hours**

HIGH PERFORMANCE RISC ARCHITECTURE

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

FOR FURTHER READING

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers-Counters- Interrupts.

Total: 45 Hours

Reference(s)

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.
3. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.
4. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.
5. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

22OEC03 PRINCIPLES OF COMMUNICATION SYSTEMS

3 0 0 3

Course Objectives

- To study the various analog and digital modulation techniques
- To study the various digital communication techniques
- To enumerate the idea of spread spectrum modulation
- To study the design concepts of satellite and optical communication

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Illustrate the process involved in Amplitude, Frequency and phase modulation systems.
2. Analyze the performance of different digital modulation /demodulation techniques.
3. Analyze Pulse Code Modulation scheme for the transmission of analog data in digital format.
4. Apply the concepts of spread spectrum modulation techniques to eradicate interference in wireless communication.
5. Analyze the system design of satellite and optical communication.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

FUNDAMENTALS OF ANALOG COMMUNICATION

Principles of amplitude modulation, AM envelope, frequency spectrum and bandwidth, modulation index and percent modulation, AM Voltage distribution, AM power distribution, Angle modulation. FM andPM waveforms, phase deviation and modulation index, frequency deviation and percent modulation,Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves

UNIT II **9 Hours**

DIGITAL COMMUNICATION

Introduction, Shannon limit for information capacity, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Minimum Shift Keying (MSK),Phase Shift Keying (PSK), BPSK, QPSK, 8 PSK Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency,Comparison of various Digital Communication System (ASK - FSK - PSK - QAM).

UNIT III **9 Hours**

DIGITAL TRANSMISSION

Introduction, Pulse modulation, PCM , PCM sampling, sampling rate, signal to quantization noise rate,companding, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission, Intersymbol interference, eye patterns.

UNIT IV **9 Hours**

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques, wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT V **9 Hours**

SATELLITE AND OPTICALCOMMUNICATION

Satellite Communication Systems-Keplers Law,LEO and GEO Orbits, footprint, Link model-OpticalCommunication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub,D L Schilling,G Saha ,Principles of Communication,3/e,2007.
4. B.P.Lathi,Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

22OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	1	-	-	-	-	-	-	-	-	-	-	2
2	1	2	2	3	-	-	-	-	-	-	-	-	-	-	2
3	1	1	2	3	-	-	-	-	-	-	-	-	-	-	2
4	1	1	3	-	-	-	-	-	-	-	-	-	-	-	2
5	1	2	3	3	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology ; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

22OEE01 VALUE ENGINEERING 3 0 0 3

Course Objectives

- To understand the concept of value engineering in order to reduce cost of product or process or service.
- To implement creative and innovative techniques using FAST diagram.
- To study benefits of Value Engineering for various industries.

Programme Outcomes (POs)

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

Course Outcomes (COs)

1. Apply the concepts of value and value engineering to prepare a job plan
2. Analyse the cost and worth of a product/service using the principles of economics
3. Evaluate the value of a product/service to take managerial decisions
4. Apply the softskills in understanding team building, team work and report writing
5. Asses the functions and values of product/services in industries using case studies

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	-	-	-	-	-	-	-	-	-	3	1	1	-	-
2	-	-	-	-	-	-	-	-	-	1	3	1	1	-	-
3	-	-	-	-	-	-	-	-	-	-	3	1	3	-	-
4	-	-	-	-	-	-	-	-	-	1	3	2	-	1	-
5	-	-	-	-	-	-	-	-	-	2	3	1	-	2	-

UNIT I 9 Hours

INTRODUCTION TO VALUE ENGINEERING

Historical perspective of Value Engineering, Aims and objectives of Value Engineering, Concept of Value, Value Engineering concerned with Economic Value, Value Engineering Job plan.

UNIT II **9 Hours**

FUNCTIONAL ANALYSIS

Function-Cost-Worth analysis: Function Analysis System Technique (FAST); Review of principles of engineering economics

UNIT III **9 Hours**

EVALUATION OF VALUE ENGINEERING

Evaluation of function, Problem setting system, problem solving system, setting and solving management - decision - type and services problem, evaluation of value

UNIT IV **9 Hours**

HUMAN ASPECTS IN VALUE ENGINEERING

Team building; Life cycle costing; Managing Value Engineering Study; Value Engineering Report writing; Presentation Skill - Individual and Team Presentations; Implementation and follow-up

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe Value Engineering Case studies in the Industries like Manufacturing; Construction; Health Care; Process.

Total: 45 Hours

Reference(s)

1. Kumar Mukhopadhyaya, Value Engineering Mastermind - From Concepts to Certification, Response. Business Books from SAGE, Los Angeles / London / New Delhi / Singapore / Washington DC, 2014.
2. Anil Kumar Mukhopadhyaya, Value Engineering -Concepts, Techniques and Applications, Response Books, A Division of SAGE Publications, New Delhi / Thousand Oaks / London, 2003
3. R. D. Miles, Techniques of Value analysis & Engineering, McGraw Hill, 2000.
4. E. Midge Arthur, Value Engineering -A Systematic Approach, McGraw Hill Book Co., New York, 2000.
5. Zimmerman, Value Engineering - A Practical Approach, CBS Publishers & Distributors, New Delhi, 2000.

22OEE02 ELECTRICAL SAFETY 3 0 0 3

Course Objectives

- To provide knowledge on basics of electrical fire and statutory requirements for electrical safety
- To understand the causes of accidents due to electrical hazards
- To know the various protection systems in Industries from electrical hazards
- To know the importance of earthing
- To distinguish the various hazardous zones and applicable fire proof electrical devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

Course Outcomes (COs)

1. Analyze the basic concepts in electrical circuit and hazards involved in it.
2. Analyze the electrical hazards in the workplace and its impacts.
3. Examine the operation of various protection systems from electrical hazards.
4. Analyze the various safety procedures involved in the industries
5. Explore the different hazardous zones in Industries and their safety measures

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	-	-	-	2	1	-	-	-	-	-	2	-	-
2	1	1	-	-	-	1	2	2	-	-	-	-	1	2	-
3	1	1	-	-	-	2	-	2	1	-	-	-	2	1	-
4	1	1	-	-	-	2	1	-	-	-	-	-	1	-	-
5	1	1	-	-	-	2	1	2	1	-	-	-	2	1	-

UNIT I **9 Hours**

INTRODUCTION

Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - working principles of major electrical equipment - Typical supply situation - Indian electricity act and rules - statutory requirements from electrical inspectorate- International standards on electrical safety.

UNIT II **9 Hours**

ELECTRICAL HAZARDS

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity- Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy- current surges- over current and short circuit current-heating effects of current- Lightning, hazards, lightning arrestor, - national electrical safety code ANSI.

UNIT III **9 Hours**

ELECTRICAL SAFETY EQUIPMENT

Fuse, circuit breakers and overload relays - safe distance from lines - capacity and protection of conductor joints and connections, overload and short circuit protection - earth fault protection. FRLS insulation - insulation and continuity test - system grounding - equipment grounding - earth leakage circuit breaker (ELCB) - ground fault circuit interrupter - electrical guards - Personal protective equipment.

UNIT IV **9 Hours**

ELECTRICAL SAFETY OPERATION AND MAINTENANCE

Role of environment in selection - protection and interlock - discharge rod and earthing devices - safety in the use of portable tools - preventive maintenance - installation – earthing, specifications, earth resistance, earth pit maintenance - Fire Extinguishers - CO2 and Dry Powder schemes.

UNIT V **9 Hours**

BENEFITS OF VALUE ENGINEERING

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies – electrical safety standards. (IS, API and OSHA standards)

Total: 45 Hours

Reference(s)

1. Fordham Cooper, W., “Electrical Safety Engineering, Butterworth and Company”, London, Third Edition, 2013.
2. “Indian Electricity Act and Rules”, Government of India.
3. “Power Engineers”, Handbook of TNEB, Chennai, 2010.
4. “Accident prevention manual for industrial operations”, N.S.C., Chicago, 1982.
5. John Cadick, P.E., Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, “Electrical Safety Handbook”, Fourth Edition, Tata Mcgraw Hill, 2014.

22OEI03 FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- Understand the basic components of Virtual Instrumentation system.
- Learn the developing VIs based on Lab VIEW software.
- To learn to develop applications based on Virtual Instrumentation system.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Outline the concepts of traditional instruments and virtual instruments
2. Conclude the overview of modular programming and the structuring concepts in VI programming
3. Attribute the procedure to install DAQ in various OS and its interfacing methods
4. Implement the VI toolsets for specific applications
5. Generate the applications using Virtual Instrumentation software

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1	1	-	-	-	-	-	-	-	-	-	-	2
2	3	3	2	2	2	-	-	-	-	2	2	2	-	-	2
3	2	2	2	1	-	-	-	-	-	-	-	-	-	-	2
4	3	3	3	1	2	-	-	-	-	1	2	2	-	-	2
5	3	2	2	1	2	-	-	-	-	1	2	2	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming.

UNIT II **9 Hours**

VI PROGRAMMING TECHNIQUES

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III **9 Hours**

DATA ACQUISITION

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT IV **9 Hours**

VI TOOLSETS

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V **9 Hours**

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total: 45 Hours

Reference(s)

1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

22OEI04 OPTOELECTRONICS AND LASER INSTRUMENTATION 3 0 0 3

Course Objectives

- To enhance the student knowledge in fiber optics fundamentals and fabrication
- To be recognized with industrial applications of fibers
- To understand the fundamental concepts about lasers
- To identify and describe various fiber optic imaging and optoelectronic sensor applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Attribute the properties of optical fibers, their light sources and detectors.
2. Implement the fiber-optic sensor for the measurement of various physical quantities.
3. Conclude the fundamentals of laser, types of laser and its working.
4. Outline the applications of laser for industrial applications.
5. Differentiate the use of laser instruments for various medical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2
2	3	2	1	2	-	-	-	-	-	-	-	-	-	-	2
3	3	2	1	-	-	-	-	-	-	-	-	-	-	-	2
4	3	2	2	2	-	-	-	-	-	-	-	-	-	-	2
5	3	2	2	2	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

OPTICAL FIBERS AND THEIR PROPERTIES

Introduction to optical fibers - Light guidance - Numerical aperture - Dispersion - Different types of fibers and their properties - Light Sources for fiber optics, Photo detectors, source coupling, splicing and connectors.

UNIT II **9 Hours**

INDUSTRIAL APPLICATION OF OPTICAL FIBERS

Fiber optics instrumentation system - optical fiber sensors, Measurement of pressure, temperature, current, voltage and liquid level - fiber optic communication set up - different types of modulators - detectors.

UNIT III **9 Hours**

LASER FUNDAMENTALS

Fundamental characteristics of lasers: laser rate equation - three level system - four level system - properties of laser beams - laser modes - resonator configuration - Q- switching and mode locking - cavity dumping - types of lasers: gas lasers, solid state lasers, liquid lasers and semiconductor lasers.

UNIT IV **9 Hours**

INDUSTRIAL APPLICATION OF LASERS

Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants - material processing: laser heating, melting, welding and trimming of materials - removal and vaporization - calculation of power requirements of laser for material processing.

UNIT V **9 Hours**

HOLOGRAM AND MEDICAL APPLICATIONS

Holography: basic principle, methods - holographic interferometry and application, holography for non-destructive - medical applications of lasers, laser and tissue interactive - laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.

Total: 45 Hours

Reference(s)

1. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

22OBM01 OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES

3 0 0 3

Course Objectives

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

Programme Outcomes (POs)

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	-	3	2	1	-	-	-	1	-	-	-	2	-	-	2
2	-	2	2	2	-	-	-	1	-	-	-	2	-	-	2
3	-	3	2	2	-	-	-	1	-	-	-	2	-	-	2
4	-	2	2	2	-	-	-	1	-	-	-	2	-	-	2
5	-	3	2	2	-	-	-	1	-	-	-	2	-	-	2

UNIT I **9 Hours**

MANAGEMENT ASPECTS

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

UNIT II **9 Hours**

STRATEGIES AND TOOLS

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control.

UNIT III **9 Hours**

COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

UNIT IV **9 Hours**

OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders

9 Hours

UNIT V

OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of Sources and scenarios of radiation incidents – guidance for protection of emergency responders - Occupational health surveillance of persons occupationally exposed to radiation in emergencies

.

Total: 45 Hours

Reference(s)

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety andHealth; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition.Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

22OBM02 AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT

3 0 0 3

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	1	1	1	-	-	-	-	-	-	2
2	2	-	-	-	-	1	1	1	-	-	-	-	-	-	2
3	-	2	-	-	-	1	1	1	-	-	-	-	-	-	2
4	2	2	-	-	-	1	1	1	-	-	-	-	-	-	2
5	2	-	-	-	-	1	1	1	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

esign and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett,"Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006

22OBM03 HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Asses the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	-	-	-	1	1	-	-	-	-	-	-	-	2
2	1	2	-	-	-	2	2	-	-	-	-	-	-	-	2
3	1	2	-	-	-	2	2	-	-	-	-	-	-	-	2
4	1	2	-	-	-	1	1	-	-	-	-	-	-	-	2
5	3	2	-	-	-	1	1	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products

UNIT II **9 Hours**

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery : Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**

INSTRUMENTATION SYSTEMS

Optical sensors , Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards

UNIT V **9 Hours**

APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration

.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3 rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4 th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.

22OBT01 BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more ecofriendly options.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	-	-	-	3	-	-	-	-	-	-	-	2
2	2	1	-	3	-	-	1	-	-	-	-	-	-	-	2
3	1	2	-	2	-	2	3	-	-	-	-	-	-	-	2
4	2	3	-		-	2	3	-	-	-	-	-	-	-	2
5	1	2	3	3	-	-	1	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

22OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Assess the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Select the Traditional fermented foods products based on its raw material
4. Find a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	1	1	-	-	-	-	-	-	-	-	-	-	-	2
4	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2
5	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

22OFD02 FOOD LAWS AND REGULATIONS

3 0 0 3

Course Objectives

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Assess the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Apply the voluntary regulatory standards as per application
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1	-	-	-	-	-	-	-	-	-	-	-	2
2	-	1	-	-	-	1	2	1	-	-	-	-	-	-	2
3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
4	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
5	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

22OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES 3 0 0 3

Course Objectives

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Implement various post-harvest handling practices to effectively store fruits and vegetables, ensuring quality preservation.
2. Analyze suitable preservation methods (such as sugar, salt, or dehydration) to produce value-added products from fruits and vegetables.
3. Evaluate the need for low temperature and irradiation methods to preserve specific fruits and vegetables, assessing their effectiveness.
4. Apply concentration and fermentation techniques to preserve fruits and vegetables, enhancing their shelf life and quality.
5. Implement the canning process for preserving fruits and vegetables, ensuring product safety and quality.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2	1	-	-	1	-	-	-	-	-	-	-	2
2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2
3	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
4	1	-	1	-	-	-	-	-	-	-	-	-	-	-	2
5	2	1	1	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

22OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tools to design, analyze and provide solutions for fluid flow and thermal related applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Identify the processing technologies used for cereals.
2. Analyze the composition and nutritional value of millets.
3. Understand the changes in pulses and legumes during processing.
4. Develop skills in oilseed processing technology.
5. Understand the relationship between storage, processing, and quality of food grains.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	2	-	2	-	-	-	-	-	-	-	-	2
2	1	2	-	2	-	1	-	-	-	-	-	-	-	-	2
3	2	2	-	1	-	2	-	-	-	-	-	-	-	-	2
4	2	3	-	2	-	2	-	-	-	-	-	-	-	2	2
5	2	2	-	2	-	3	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

22OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	3	-	-	-	2	-	2	2	-	2	2	-	2
2	3	2	3	-	-	-	1	-	2	3	-	2	2	-	2
3	3	2	3	-	-	-	2	-	2	3	-	2	2	-	2
4	3	2	3	-	-	-	2	-	2	3	-	2	2	-	2
5	3	2	3	-	-	-	2	-	2	3	-	2	2	-	2

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNIT IV **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. https://www.marthastewart.com/274411/fashion-crafts

22OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Assess the elements of interior design concepts and resolve the personality requirements
2. Carry out graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Analyze the roles and responsibilities of an interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	-	-	1	-	-	-	-	-	-	2	-	2
2	3	2	3	-	2	3	-	2	-	-	-	-	3	-	2
3	3	3	3	-	2	2	-	2	-	-	-	-	2	-	2
4	3	3	3	-	2	3	-	2	-	-	-	-	2	-	2
5	3	2	-	-	2	-	-	3	-	-	-	-	3	-	2

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

22OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tools to design, analyze and provide solutions for fluid flow and thermal related applications
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	-	-	-	-	1	-	-	-	-	-	-	2
2	2	3	2	-	-	-	-	-	2	-	-	-	2	2	2
3	2	3	2	-	3	-	-	-	-	-	-	-	2	2	2
4	2	2	2	-	-	-	-	-	2	-	-	-	2	2	2
5	2	2	2	-	-	-	-	-	2	-	-	-	-	2	2

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

22OPH01 NANOMATERIALS SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on Nanoscience
- Explore different techniques of producing nanomaterials
- Create expertise on the applications of nanomaterials in various fields

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Analyze the origin of nanomaterials from ancient applications to modern nanotechnology
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Analyze the magnetic properties of nanomaterials and their applications in data storage and spintronics
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
2	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
3	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
4	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
5	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

9 Hours

UNIT II

NANOMATERIALS SYNTHESIS METHODS

Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.

9 Hours

UNIT III

CHARACTERIZATION TECHNIQUES

General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.

9 Hours

UNIT IV

SEMICONDUCTOR NANOSTRUCTURES

Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes- structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials

9 Hours

UNIT V

NANOMACHINES AND NANODEVICES

Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - - organic photovoltaic cells- spintronics

Total: 45 Hours

Reference(s)

1. Willam A. Goddard, Donald W.Brenner, "Handbook of Nanoscience, Engineering, and Technology", CRC Press, 2012
2. Charles P. Poole Jr and. Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2007
3. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, AuliceScibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

22OPH02 SEMICONDUCTOR PHYSICS AND DEVICES 3 0 0 3

Course Objectives

- Impart knowledge in physical properties of semiconducting materials
- Analyze the factors affecting the operation of semiconductor devices
- Apply the physics of semiconductors to develop semiconductor devices

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Analyze the formation of drift current due to the movement of charge carriers under an electric field
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Analyze the operation of a Bipolar Junction Transistor (BJT) in active, cutoff, and saturation modes
4. Apply the principles of charge storage in floating-gate transistors for non-volatile memory applications
5. Outline the efficiency factors affecting the performance of opto-electronic devices

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
2	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
3	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
4	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2
5	3	2	2	1	1	-	-	-	-	-	-	1	-	-	2

UNIT I **9 Hours**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

UNIT II **9 Hours**

P-N JUNCTION

Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.

UNIT III **9 Hours**

BIPOLAR JUNCTION TRANSISTOR

The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor

UNIT IV **9 Hours**

MOSFET

The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM

UNIT V **9 Hours**

PHOTONIC DEVICES

Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells - efficiency

Total: 45 Hours

Reference(s)

1. Donald A Neamen, "Semiconductor Physics and Devices", Tata McGraw Hill, 2012
2. S. M. Sze and M. K. Lee, "Semiconductor Devices, Physics and Technology", John-Wiley & Sons, 2015
3. Ben. G. Streetman and S. K. Banerjee , "Solid State Electronic Devices", Pearson Education Ltd, 2015
4. C. Kittel, "Introduction to Solid State Physics", John-Wiley & Sons, 2012
5. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata McGraw Hill, 2010
6. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006

22OPH03 APPLIED LASER SCIENCE 3 0 0 3

Course Objectives

- Impart knowledge on laser science
- Explore different strategies for producing lasers
- Create expertise on the applications of lasers in various fields

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Illustrate the transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	-	-	-	-	-	-	-	1	-	-	2
2	3	2	2	1	-	-	-	-	-	-	-	1	-	-	2
3	3	2	2	1	-	-	-	-	-	-	-	1	-	-	2
4	3	2	2	1	-	-	-	-	-	-	-	1	-	-	2
5	3	2	2	1	-	-	-	-	-	-	-	1	-	-	2

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

22OPH04 BIOPHOTONICS 3 0 0 3

Course Objective:

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Use research–based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO3 Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues. Analyze the fundamental laws of optics and their role in light interaction with biological cells and tissues
2. Apply the principles of light interaction with biological tissues to enhance imaging resolution and contrast
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	2	1	-	-	-	-	-	-	-	-	-	2
2	2	3	2	2	1	-	-	-	-	-	-	-	-	-	2
3	3	3	2	2	1	-	-	-	-	-	-	-	-	-	2
4	4	3	2	2	1	-	-	-	-	-	-	-	-	-	2
5	5	3	2	2	1	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO BIOPHOTONICS

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**

PHOTOBIOLOGY

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photoexcitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**

BIONANO PHOTONICS

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**

TISSUE ENGINEERING WITH LIGHT

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters of tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**

BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering – Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Introduction to Biophotonics, ParasN.Prasad, WileyInter-science, AJohnWiley & Sons, Inc., Publication (Class notes are developed mainly based on this book.)
2. Introduction to Biomedical Imaging, Andrew G.Webb, 2002, IEEE Press.
3. Biomedical Optics: Principles and Imaging, Lihong.V.Wang, Hsin.-I.Wu, 2007, Wiley Interscience 2007. & "An Introduction to Biomedical Optics", R.Splinterand B.A.Hooper, Taylor & Francis
4. Bioimaging Current Concepts in Light and Electron Microscopy, DouglasE.Chandler & Robert W.Roberson, Jones and Bartlett publishers.
5. Optical Imaging and Microscopy : Techniques and Advanced Systems, Peter Török and Fu-JenKao, 2004, Springer.

22OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supramolecules
- To summarize the soft matter proprties of structures and components of life

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Analyze the structural and mechanical differences between soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Analyze the optical and electro-optical properties of liquid crystals used in display technologies
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	2
2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I 9 Hours

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

REFERENCES

1. Richard A L Jones, Soft Condensd Matter, Oxford University Press, UK, 2002
2. Masao Doi, Soft Matter Physics,Oxford University Press, UK, 2013.
3. Ian W. Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

22OCH01 CORROSION SCIENCE AND ENGINEERING

3 0 0 3

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply fundamental principles of corrosion science to calculate corrosion rates, analyze metal degradation and interpret Pourbaix diagrams to predict corrosion behavior in various industrial environments.
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Analyze the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Analyze the rate of corrosion on metals using electrochemical methods of testing
5. Analyze the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	2
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	2
3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.html

22OCH02 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply knowledge of polymerization mechanisms to predict the formation of different polymer products under various reaction conditions and catalysts
2. Apply suitable polymerization techniques to synthesize the high quality polymers
3. Apply the structural, thermal, and mechanical properties of polymers for different industrial applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	2
2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2
4	1	1	2	-	-	-	-	-	-	-	-	-	-	-	2
5	1	3	2	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2008
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

22OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply principles of electrochemistry to evaluate performance parameters such as energy density, charge efficiency, and cycle life for different cell types.
2. Asses the suitability of various primary, secondary, and reserve batteries for portable electronics and EV applications considering specifications, safety, and recycling aspects.
3. Evaluate and compare different fuel cell types in terms of working principles, components, applications, and environmental impact to propose suitable technology for a given scenario.
4. Develop efficient hydrogen energy solutions by integrating suitable production, storage, and application methods while addressing limitations.
5. Analyse future prospects of renewable fuels and design strategies to enhance efficiency and economy of hydrogen and solar-based energy conversion systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	3	-	-	-	-	-	-	-	-	-	-	2
2	2	3	-	-	-	2	2	-	-	-	-	-	-	-	2
3	2	2	-	3	-	-	2	-	-	-	-	-	-	-	2
4	2	2	3	-	-	-	2	-	-	-	-	-	-	-	2
5	2	2	-	3	-	-	2	-	-	-	-	-	-	-	2

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium,and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

22OMA01 GRAPH THEORY AND COMBINATORICS

3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	2

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

22OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PSO3: Execute professional capabilities to competitively work in industries with global Standards by implementing latest tools and techniques

Course Outcomes (COs)

1. Apply management principles to assess managerial roles, business types, and current organizational trends.
2. Implement planning processes and tools to create objectives, policies, and decisions
3. Assess organizational structures and HR practices for effective system design.
4. Analyze motivation, leadership, and communication strategies to influence organizational behavior.
5. Develop control techniques and IT tools to monitor performance and productivity.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	2
2	3	-	-	-	-	-	-	1	-	-	-	1	-	-	2
3	3		-	-	-	-	-	1	-	-	-	1	-	-	2
4	2	2	-	-	-	-	-	1	-	-	-	1	-	-	2
5	2	2	2	-	-	-	-	1	-	-	-	1	-	-	2

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

22OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- To develop an understanding of the basics of entrepreneurship and its role in economic development.
- To explore fundamental concepts of creativity and innovation for effective idea generation techniques.
- To familiarize students with the principles of business laws relevant to entrepreneurial ventures.
- To empower learners to apply financial tools for project evaluation and resource management.
- To enhance the ability to manage operations through strategic planning and quality improvement techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply the principles of entrepreneurship to identify types, characteristics, and processes of entrepreneurial ventures in economic development.
2. Analyze various creative idea-generation techniques such as brainstorming, lateral thinking, and analogies to develop innovative business solutions.
3. Interpret business laws including contract acts, negotiable instruments, and company law components to ensure legal compliance in entrepreneurial contexts.
4. Demonstrate the use of financial tools such as break-even analysis, cash flow analysis, and project evaluation to assess business viability within the course duration.
5. Design an integrated operations strategy by planning layout, capacity, inventory systems, and quality improvement methods such as lean and six sigma for an entrepreneurial setup.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	2	-	-	-	-	-	-	2
2	2	3	-	-	-	-	-	2	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	2	-	-	-	-	-	-	2
4	2	2	-	-	-	-	-	2	-	-	-	-	-	-	2
5	2	2	2	-	-	-	-	2	-	-	-	-	-	-	2

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

22OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- To develop an understanding of marketing strategies, market segmentation, and the marketing mix to effectively address business challenges.
- To equip learners with the knowledge of human resource planning, recruitment, and training, alongside insights into labor laws like the Factories Act 1948.
- To familiarize students with the principles of direct and indirect taxation, including GST, income tax, and corporate tax, to ensure compliance and financial efficiency.
- To explore fundamental concepts of government policies, institutional support, and financial assistance available for entrepreneurial ventures.
- To train students to effectively prepare comprehensive business plans encompassing technical, financial, and market feasibility to evaluate entrepreneurial viability.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply marketing segmentation, targeting, and positioning techniques to formulate appropriate marketing strategies for a proposed business case.
2. Analyze human resource functions such as recruitment, selection, and development to illustrate effective HR planning and HRIS implementation in small and medium enterprises.
3. Investigate the impact of direct and indirect taxation systems, including GST and MAT, to assess their implications on business profitability and legal compliance.
4. Interpret the roles of government and institutional support systems such as NIESBUD, TIIC, and MSME to demonstrate their relevance in fostering entrepreneurship development.
5. Create a comprehensive and viable business plan by integrating marketing, production, financial, and HR components along with regulatory and feasibility considerations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	2	-	-	-	-	-	-	2
2	2	3	-	-	-	-	-	2	-	-	-	-	-	-	2
3	2	2	2	2	-	-	-	2	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	2	-	-	-	-	-	-	2
5	2	2	2	-	-	-	-	2	-	-	-	-	-	-	2

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

22OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques

Course Outcomes (COs)

1. Apply the understanding of religious and cultural diversity to promote national integration and harmony
2. Build self-confidence, professional behavior, and interpersonal effectiveness through leadership and personality development skills.
3. Develop a spirit of selfless social service and civic responsibility for societal well-being.
4. Implement physical and mental wellness practices to enhance personal discipline and communication effectiveness.
5. Analyze the roles, structure, and leadership responsibilities in the Indian Armed Forces and NCC for contributing to national security and service.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	1	2	2	2	-	-	-	-	2
2	2	2	3	-	-	-	1	2	2	2	-	-	-	-	2
3	2	2	3	-	-	2	1	2	2	2	-	-	-	-	2
4	2	-	-	-	-	-	1	2	2	2	-	-	-	-	2
5	2	3	-	-	-	-	1	2	2	2	-	-	-	-	2

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga- Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Army, navy, Air force and Central armed policed forces- Modes of entry into army, police and CAPF- Naval expeditions & campaigns. History, Geography of Border / Coastal areas. EEZ maritime security & ICG. Modes of Entries in armed forces. Security challenges & role of cadets in Border management.

Aims, Objectives and org of NCC- Incentives- Duties of NCC cadets- NCC Camps: types and conduct.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

22OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

Course Outcomes (COs)

1. Apply CAD modeling techniques (wireframe, surface, and solid modeling) to design mechanical components using Constructive Solid Geometry (CSG) and Boundary Representation (B-rep) methods.
2. Analyze CNC machine operations and formulate G-code programs for turning and milling operations using linear and circular interpolation.
3. Develop an understanding of additive manufacturing (AM) processes and analyse their advantages over traditional CNC machining.
4. Design and develop 3D models for AM by converting CAD files into STL format, verifying and repairing them for defect-free part fabrication.
5. Analyze different AM systems and apply them in reverse engineering, medical, automotive, aerospace, and electronics industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
3	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
4	2	2	3	2	3	-	-	-	-	-	-	-	2	-	-
5	2	2	2	2	3	-	-	-	-	-	-	-	2	-	-

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

22OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

Course Outcomes (COs)

1. Apply industrial engineering principles to select suitable plant layouts for the given production systems.
2. Analyze process planning and production control methods to improve scheduling, routing, and resource utilization in manufacturing systems.
3. Investigate work systems and ergonomics to identify optimize human-machine interactions.
4. Develop inventory models and material handling layouts to enhance production flow and reduce operational costs.
5. Design system-level strategies by integrating maintenance practices to ensure reliability and continuity in industrial operations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	-	1	-	-	-	-	-	-	-	-	2	-
2	3	3	1	-	2	-	-	-	-	-	2	-	-	2	-
3	1	3	3	-	2	-	-	-	-	-	-	-	-	2	-
4	2	3	1	-	2	-	-	-	-	-	-	-	-	2	-
5	2	3	1	-	2	-	-	-	-	-	-	-	-	2	-

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

22OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4.Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.
PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.
PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Apply maintenance planning principles to develop cost-effective maintenance strategies, measurable through a maintenance plan.
2. Analyze maintenance categories and implement preventive maintenance schedules with lubrication methods.
3. Investigate condition monitoring techniques to validate equipment health using noise and vibration measurements.
4. Formulate failure analysis procedures using Non-Destructive Testing to design repair methods for mechanical components.
5. Develop a computer-aided maintenance management system (CAMMS) to integrate spare parts inventory and performance reporting.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	3	-	1	1	1	1	-	-	2	1	3	-	1
2	3	3	1	-	-	1	1	-	-	-	-	1	-	3	2
3	-	3	-	3	2	1	-	-	-	1	-	-	-	1	3
4	-	2	3	3	1	-	-	-	-	-	1	1	1	3	-
5	-	-	3	1	3	-	1	-	1	1	2	1	3	-	3

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

22OME04 SAFETY ENGINEERING 3 0 0 3

Course Objectives

- To study the principles of safety management system.
- To introduce the provisions contained in the industrial laws.
- To provide knowledge on safety requirements for engineering industry.
- To learn safety requirement for chemical industry.
- To study the various safety measures adopted in construction industries.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1. Implement new ideas on product / process development by utilizing the knowledge of design and manufacturing.

PSO2. Apply knowledge acquired in mechanical engineering with an analytical / computational tool to design, analyze and provide solutions for fluid flow and thermal related applications.

PSO3. Execute professional capabilities to competitively work in industries with global Standards by implementing recent tools and techniques.

Course Outcomes (COs)

1. Analyze the accident causation models and safety performance indices, to develop effective job safety analysis and accident investigation techniques.
2. Design the compliant safety and health frameworks for industrial operations, by analyzing the Factory Act 1948 and Tamil Nadu Factories Rules.
3. Apply the machine guarding principles and personal protective equipment standards, to develop safety protocols for metalworking and inspection processes.
4. Interpret the HAZOP study and safety valve principles, to design safe process systems and emergency plans for chemical plant operations.
5. Develop safety strategies for high-rise building, excavation, and confined space work, by analyzing construction hazards and regulations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	2	-	3	-	-	3	-	-	-	-	2	1	-
2	2	-	-	-	-	-	-	-	-	-	-	3	1	-	2
3	3	-	-	-	-	-	-	-	2	-	-	-	2	-	1
4	2	3	2	-	2	-	-	-	-	3	-	-	-	3	-
5	2	2	2	-	3	-	-	3	-	-	-	-	2	1	-

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop,- Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.