

B.E. (Mechanical Engineering)
Revised 2018 Regulations, Curriculum & Syllabi
(for 2021-2025 batch students)



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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VISION OF THE DEPARTMENT

Seek excellence in the field of Mechanical Engineering education through knowledge and skills to cater to the requirements of the society.

MISSION OF THE DEPARTMENT

- To continuously improving the teaching and learning process to enable students to meet global needs.
- To upgrade the knowledge and skills of students, members of faculty and supporting staff through regular training.
- To produce the best minds of engineers capable of meeting expectations of Industry, Society and Entrepreneurship development.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

After graduation, the Graduates of Mechanical Engineering will be able to

- PEO I Familiarize the students with applications of fundamental Science, Technology, Engineering and Mathematics in day-to-day life and enable them to present their ideas with good communication and aptitude.
- PEO II Enable the students to design and develop product / process with appropriate research to provide solutions for requirements of industry and society.
- PEO III Assist the students to, be innovative, develop entrepreneurship or pursue higher education, be ethical in profession and create healthy environment.

PROGRAM OUTCOMES (PO)

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. 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 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. 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. 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. 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. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. 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. 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. 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.

PROGRAM SPECIFIC OUTCOMES (PSOs)

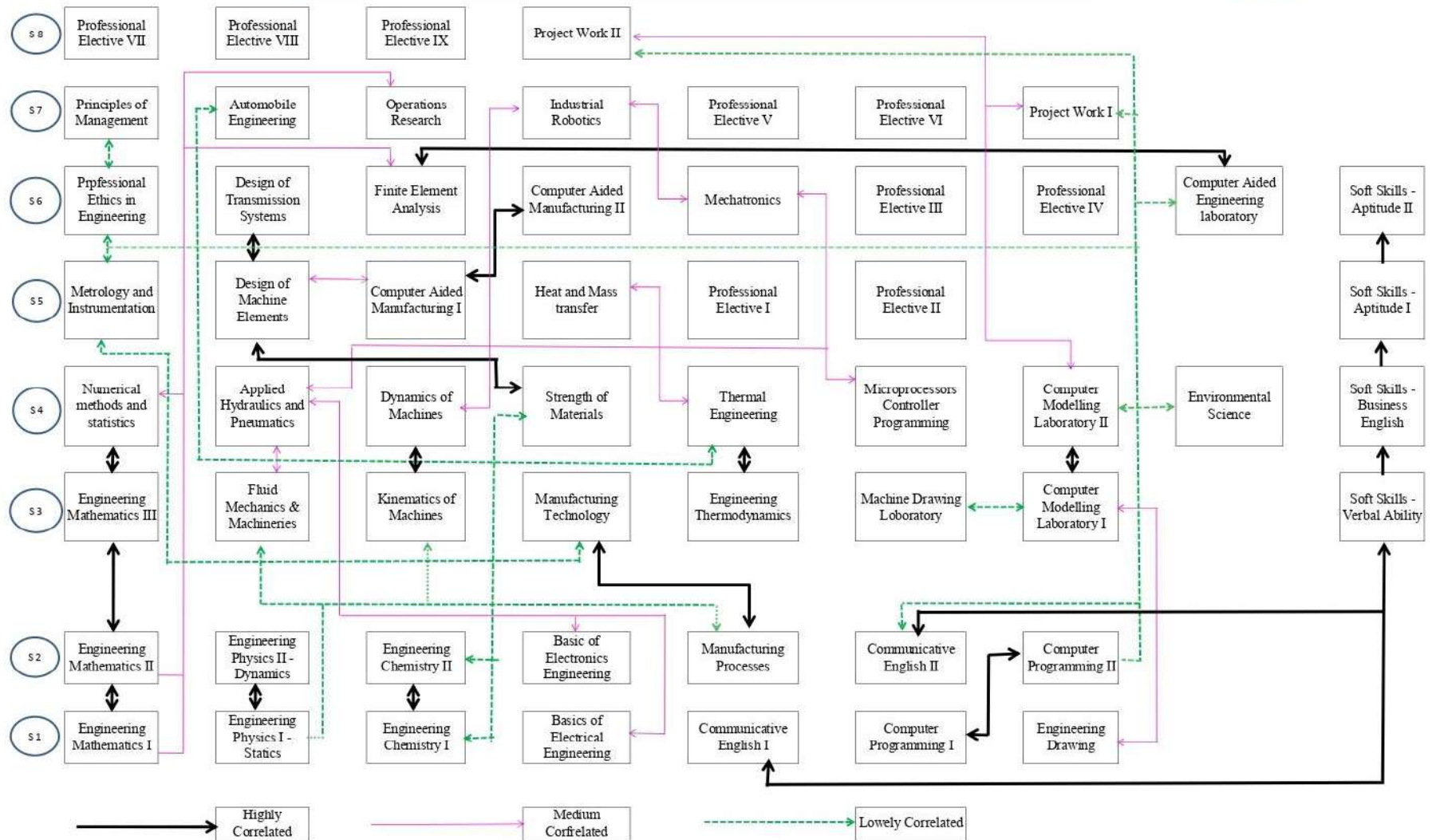
1. Design, analyse and evaluate the performance of mechanical systems.
2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost
3. Address all the fluid flow and energy transfer related problems of mechanical systems.

CORRELATION OF PEOs WITH POs AND PSOs

PEO	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	X	X	X
PEO II	X	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	X	X	X

DEPARTMENT OF MECHANICAL ENGINEERING CURRICULAM DESIGN & INTERLINKING OF COURSES

360 °
FLEXIBLE
LEARNING
FRAME WORK



DEPARTMENT OF MECHANICAL ENGINEERING - Revised R2018										
Minimum Credits to be Earned : 161										
I SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
18ME101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
18ME102	ENGINEERING PHYSICS I – STATICS	2	0	2	3	4	50	50	100	BS
18ME103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
18ME104	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3	4	50	50	100	ES
18HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HSS
18ME106	COMPUTER PROGRAMMING I	0	0	4	2	4	100	0	100	ES
18ME107	ENGINEERING DRAWING	0	0	4	2	4	100	0	100	ES
Total		10	1	16	19	27	-	-	-	-
II SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
18ME201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
18ME202	ENGINEERING PHYSICS II - DYNAMICS	2	1	0	3	3	40	60	100	BS
18ME203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
18ME204	BASIC ELECTRONICS ENGINEERING	2	0	2	3	4	50	50	100	ES
18ME205	MANUFACTURING PROCESSES	2	0	2	3	4	50	50	100	PC
	LANGUAGE ELECTIVE	1	0	2	2	3	100	0	100	HSS
Total		12	2	12	20	26	-	-	-	-

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
18ME301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
18ME302	FLUID MECHANICS AND MACHINERY	2	1	2	4	5	50	50	100	ES
18ME303	ENGINEERING THERMODYNAMICS	3	1	0	4	4	40	60	100	ES
18ME304	MANUFACTURING TECHNOLOGY	2	0	2	3	4	50	50	100	PC
18ME305	KINEMATICS OF MACHINES	3	1	0	4	4	40	60	100	PC
18ME306	MACHINE DRAWING LABORATORY	1	0	2	2	3	100	0	100	PC
18ME307	COMPUTER AIDED MODELLING LABORATORY I	0	0	4	2	4	100	0	100	EEC
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		14	4	12	23	30	-	-	-	-
IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
18ME401	NUMERICAL METHODS	3	1	0	4	4	40	60	100	BS
18ME402	APPLIED HYDRAULICS AND PNEUMATICS	2	0	2	3	4	50	50	100	PC
18ME403	DYNAMICS OF MACHINES	2	1	2	4	5	50	50	100	PC
18ME404	STRENGTH OF MATERIALS	2	1	2	4	5	50	50	100	PC
18ME405	THERMAL ENGINEERING	2	1	2	4	5	50	50	100	PC
18ME406	MICROPROCESSORS AND MICROCONTROLLER	2	0	2	3	4	50	50	100	ES
18 ME407	COMPUTER AIDED MODELLING LABORATORY II	0	0	4	2	4	100	0	100	EEC
18HS001	ENVIRONMENTAL SCIENCE	2	0	0	-	2	100	0	100	ES
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		15	4	16	24	35	-	-	-	-

V SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21ME501	METROLOGY AND INSTRUMENTATION	2	0	2	3	4	50	50	100	PC
21ME502	DESIGN OF MACHINE ELEMENTS	3	1	0	4	4	40	60	100	PC
21ME503	COMPUTER AIDED MANUFACTURING I	2	0	2	3	4	50	50	100	PC
21ME504	HEAT AND MASS TRANSFER	3	1	2	5	6	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		16	2	8	21	26	-	-	-	-
VI SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HSS
21ME602	MECHATRONICS	2	0	2	3	4	50	50	100	PC
21ME603	FINITE ELEMENT ANALYSIS	3	1	0	4	4	40	60	100	PC
21ME604	COMPUTER AIDED MANUFACTURING II	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
21ME608	COMPUTER AIDED ENGINEERING LABORATORY	0	0	4	2	4	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		18	1	10	23	29	-	-	-	-

VII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21ME701	OPERATIONS RESEARCH	3	1	0	4	4	40	60	100	PC
21ME702	INDUSTRIAL ROBOTICS	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
21ME707	PROJECT WORK I	0	0	6	3	6	50	50	100	EEC
Total		17	1	8	22	26	-	-	-	-
VIII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21ME801	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
Total		0	0	18	9	18	-	-	-	-

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
21HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
21HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
21HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
21HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS

ELECTIVES										
PROFESIONAL ELECTIVES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
VERTICAL I - DESIGN ENGINEERING										
21ME001	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3	3	40	60	100	PE
21ME002	COMPOSITE MATERIALS AND MECHANICS	3	0	0	3	3	40	60	100	PE
21ME003	COMPUTER AIDED DESIGN	3	0	0	3	3	40	60	100	PE
21ME004	MECHANICAL VIBRATIONS	3	0	0	3	3	40	60	100	PE
21ME005	ENGINEERING TRIBOLOGY	3	0	0	3	3	40	60	100	PE
21ME006	FAILURE ANALYSIS AND DESIGN	3	0	0	3	3	40	60	100	PE
21ME007	DESIGN OF HEATING VENTILATION AND AIR CONDITIONING	3	0	0	3	3	40	60	100	PE
VERTICAL II - MANUFACTURING										
21ME008	ADVANCED CASTING AND FORMING PROCESSES	3	0	0	3	3	40	60	100	PE
21ME009	NON-TRADITIONAL MACHINING PROCESSES	3	0	0	3	3	40	60	100	PE
21ME010	WELDING TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21ME011	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	3	40	60	100	PE
21ME012	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	40	60	100	PE
21ME013	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	PE
VERTICAL III - INDUSTRIAL ENGINEERING										
21ME014	OPERATIONS	3	0	0	3	3	40	60	100	PE

	MANAGEMENT									
21ME015	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	40	60	100	PE
21ME016	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	40	60	100	PE
21ME017	LEAN MANUFACTURING	3	0	0	3	3	40	60	100	PE
21ME018	ENGINEERING ECONOMICS	3	0	0	3	3	40	60	100	PE
21ME019	STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION	3	0	0	3	3	40	60	100	PE
VERTICAL IV - THERMAL ENGINEERING										
21ME020	POWER PLANT ENGINEERING	3	0	0	3	3	40	60	100	PE
21ME021	REFRIGERATION AND AIR CONDITIONING	3	0	0	3	3	40	60	100	PE
21ME022	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
21ME023	GAS DYNAMICS AND JET PROPULSION	3	0	0	3	3	40	60	100	PE
21ME024	RENEWABLE ENERGY TECHNOLOGIES	3	0	0	3	3	40	60	100	PE
21ME025	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	3	40	60	100	PE
VERTICAL V - PRODUCT DESIGN AND DEVELOPMENT										
21ME026	TOOL AND DIE DESIGN	3	0	0	3	3	40	60	100	PE
21ME027	GEOMETRIC MODELLING	3	0	0	3	3	40	60	100	PE
21ME028	ERGONOMICS	3	0	0	3	3	40	60	100	PE
21ME029	PRODUCT DATA AND LIFE CYCLE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21ME030	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	40	60	100	PE
21ME031	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3	3	40	60	100	PE
VERTICAL VI - ROBOTICS AND AUTOMATION										
21ME032	INDUSTRIAL AUTOMATION	3	0	0	3	3	40	60	100	PE
21ME033	MODELLING OF INDUSTRIAL ROBOTS	3	0	0	3	3	40	60	100	PE
21ME034	AUTOMATION SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21ME035	MATERIAL HANDLING SYSTEMS	3	0	0	3	3	40	60	100	PE
21ME036	ARTIFICIAL INTELLIGENCE IN AUTOMATION	3	0	0	3	3	40	60	100	PE
21ME037	MACHINE LEARNING IN AUTOMATION	3	0	0	3	3	40	60	100	PE

VERTICAL VII - AUTOMOTIVE ENGINEERING										
21ME038	AUTOMOTIVE SYSTEM	3	0	0	3	3	40	60	100	PE
21ME039	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	3	0	0	3	3	40	60	100	PE
21ME040	ELECTRIC AND HYBRID VEHICLE SYSTEMS	3	0	0	3	3	40	60	100	PE
21ME041	VEHICLE DYNAMICS	3	0	0	3	3	40	60	100	PE
21ME042	SMART MOBILITY AND INTELLIGENT VEHICLES	3	0	0	3	3	40	60	100	PE
21ME043	VEHICLE MAINTENANCE	3	0	0	3	3	40	60	100	PE

HONOURS DEGREE (Across Verticals)										
VERTICAL V - PRODUCT DESIGN AND DEVELOPMENT										
21MEH01	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	3	40	60	100	PE
21MEH02	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	PE
21MEH03	ENGINEERING TRIBOLOGY	3	0	0	3	3	40	60	100	PE
21MEH04	VEHICLE MAINTENANCE	3	0	0	3	3	40	60	100	PE
21MEH05	AUTOMATION SYSTEM DESIGN	3	0	0	3	3	40	60	100	PE
21MEH06	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	40	60	100	PE

HONOURS DEGREE (With Specialization)										
VERTICAL V - PRODUCT DESIGN AND DEVELOPMENT										
21MEH07	TOOL AND DIE DESIGN	3	0	0	3	3	40	60	100	PE
21MEH08	GEOMETRIC MODELLING	3	0	0	3	3	40	60	100	PE
21MEH09	ERGONOMICS	3	0	0	3	3	40	60	100	PE
21MEH10	PRODUCT DATA AND LIFE CYCLE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21MEH11	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	40	60	100	PE
21MEH12	DESIGN FOR MANUFACTURING AND ASSEMBLY	3	0	0	3	3	40	60	100	PE

MINOR DEGREE (Other than MECHANICAL Students)										
VERTICAL III - INDUSTRIAL ENGINEERING										
21MEM01	OPERATIONS MANAGEMENT	3	0	0	3	3	40	60	100	PE
21MEM02	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	40	60	100	PE
21MEM03	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	40	60	100	PE
21MEM04	LEAN MANUFACTURING	3	0	0	3	3	40	60	100	PE
21MEM05	ENGINEERING ECONOMICS	3	0	0	3	3	40	60	100	PE
21MEM06	STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION	3	0	0	3	3	40	60	100	PE

ONE CREDIT COURSES										
Code No.	Course	L	T	P	C	Hours/Week	Maximum Marks			Category
							CA	ESE	Total	
18ME0XA	GEOMETRIC DIMENSIONING AND TOLERANCING	1	0	0	1	-	100	0	100	EEC
18ME0XB	LEAN MANUFACTURING	1	0	0	1	-	100	0	100	EEC
18ME0XC	PIPING ENGINEERING	1	0	0	1	-	100	0	100	EEC
18ME0XD	PROBLEM SOLVING TECHNIQUES	1	0	0	1	-	100	0	100	EEC
18ME0XE	AUTOMOTIVE EXHAUST SYSTEM	1	0	0	1	-	100	0	100	EEC
18ME0XF	CONTINUOUS IMPROVEMENT	1	0	0	1	-	100	0	100	EEC
18ME0XG	INDIAN PATENT LAW	1	0	0	1	-	100	0	100	EEC
18ME0XH	RAILWAY TRACK TECHNOLOGY	1	0	0	1	-	100	0	100	EEC
18ME0XI	GLASS ENGINEERING	1	0	0	1	-	100	0	100	EEC
18ME0XJ	TOOL DESIGN AND MANUFACTURING	1	0	0	1	-	100	0	100	EEC
18ME0XK	5S-INTRODUCTION AND IMPLEMENTATION	1	0	0	1	-	100	0	100	EEC
18ME0XL	ENERGY AUDIT ING AND INSTRUMENTS	1	0	0	1	-	100	0	100	EEC
18ME0XM	INDUSTRIAL CONTROL VALVES	1	0	0	1	-	100	0	100	EEC
18ME0XN	INDUSTRIAL GEARBOX DESIGN	1	0	0	1	-	100	0	100	EEC
18ME0XO	PRODUCT VALIDATION TECHNIQUES AND ENVIRONMENTAL TESTING	1	0	0	1	-	100	0	100	EEC
18ME0XP	8D PROBLEM SOLVING METHODOLOGY	1	0	0	1	-	100	0	100	EEC

18ME0XQ	ADVANCED PRODUCT QUALITY PLANNING	1	0	0	1	-	100	0	100	EEC
18ME0XR	DESIGN OF ROTOR SHAFTS	1	0	0	1	-	100	0	100	EEC
18ME0XS	SAFETY MANAGEMENT IN INDUSTRY	1	0	0	1	-	100	0	100	EEC
18ME0XT	MODELLING AND ANALYSIS OF UNDERWATER ROBOTS	1	0	0	1	-	100	0	100	EEC
22ME0XU	IOT INTEGRATED AUTOMATION SYSTEMS	1	0	0	1	-	100	0	100	EEC
18ME0XV	AUTONOMOUS MOBILE ROBOT USING PYTHON C in ROS	1	0	0	1	-	100	0	100	EEC

OPEN ELECTIVES										
Code No.	Course	L	T	P	C	Hours/Week	Maximum Marks			Category
							CA	ESE	Total	
21OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	PE
21OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	PE
21OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	PE
21OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
21OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	PE
21OEC01	BASICS OF ANALOG AND DIGITAL ELECTRONICS	3	0	0	3	3	40	60	100	PE
21OEC02	MICROCONTROLLER PROGRAMMING	3	0	0	3	3	40	60	100	PE
21OEC03	PRINCIPLES OF COMMUNICATION SYSTEMS	3	0	0	3	3	40	60	100	PE
21OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	PE
21OEI03	FUNDAMENTALS OF VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21OEI04	OPTOELECTRONICS AND LASER INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21OBT01	BIOFUELS	3	0	0	3	3	40	60	100	PE
21OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	PE
21OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	PE
21OFD03	POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	PE
21OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	PE

21OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	PE
21OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	PE
21OPH01	NANOMATERIALS SCIENCE	3	0	0	3	3	40	60	100	PE
21OPH02	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	40	60	100	PE
21OPH03	APPLIED LASER SCIENCE	3	0	0	3	3	40	60	100	PE
22OPH04	BIO-PHOTONICS	3	0	0	3	3	40	60	100	PE
21OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	PE
21OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	PE
21OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	PE
21OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	PE
21OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	PE
21OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	PE
21OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	PE
21OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	PE
21OGE04	NATION BUILDING: LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	PE

OPEN ELECTIVES (Not for MECHANICAL Students)										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
21OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	PE
21OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	PE
21OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	PE
21OME04	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	4	4	-	-	-	-	28	18%	15%	20%
2	ES	7	5	8	3	-	-	-	-	23	14%	15%	20%
3	HSS	2	2	-	-	-	2	-	-	6	4%	5%	10%
4	PC	-	3	9	15	15	12	7	-	61	38%	30%	40%
5	PE	-	-	-	-	6	9	12	0	27	17%	15%	20%
6	EEC	-	-	2	2	-	-	3	9	16	10%	7%	10%
Total		19	20	23	24	21	23	22	9	161	100%	-	-

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

18ME101 ENGINEERING MATHEMATICS I**3 1 0 4****Course Objectives**

- Understand the concepts of vectors and Eigenvectors for different matrices to describe the stability of the linear systems in engineering fields
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Represent the different forms of coordinate system in complex plane and characteristics of linear systems by Eigenvalues and Eigenvectors.
2. Analyse various types of functions and their differentiation techniques involved in engineering fields
3. Implement different methods of integration used in engineering problems.
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

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

UNIT I**9 Hours****COMPLEX NUMBERS, VECTORS AND MATRICES**

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II**9 Hours****CALCULUS**

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

UNIT III

9 Hours

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV

9 Hours

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule. Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V

9 Hours

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchy's Residue Theorem.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaum s Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.

18ME102 ENGINEERING PHYSICS I-STATICS**2023****Course Objectives**

- Familiarise basic concepts and force systems
- Provide knowledge on statics of particles in space with moment
- Impart knowledge on equilibrium of rigid bodies
- Study the moment of surfaces and solids
- Learn the concepts of static friction

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Implement the free body diagram technique to resolve the forces involved in the real world mechanical systems
2. Compute the moment created by the applied forces with reference to any centre/axis in 2D & 3D space
3. Assess the appropriate support system for the given force system due to various reactions.
4. Calculate the centroid, centre of gravity for geometrical bodies and moment of inertia for two dimensional sections.
5. Analyse the mechanism of friction and various frictional forces involved in mechanical systems

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**5 Hours****BASIC CONCEPTS AND FORCE SYSTEM**

Introduction to mechanics - idealization of mechanics - laws of mechanics - principle of transmissibility. Force- types - system of forces - resultant forces - composition of forces - resolution of force - free body diagram.

UNIT II**6 Hours****STATICS OF PARTICLES AND FORCE SYSTEM**

Equilibrium of particles. Moment of force, moment of couple - equilibrant moment about point. Simplification of force and couple systems.

UNIT III STATICS OF RIGID BODIES Equilibrium of rigid bodies in two dimensions. Trusses - method of joints and method of sections. Beams - types of loads, supports and their reactions. Two and three force members - frames.	7 Hours
UNIT IV PROPERTIES OF SURFACES AND SOLIDS Centroid - Determination of area, volume and mass - Pappus and Guldinus theorems - moment of inertia of plane and areas - radius of gyration, parallel axis and perpendicular axis theorems. Product of inertia, mass moment of inertia.	6 Hours
UNIT V FRICTION Origin of friction - types - laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.	6 Hours
1 EXPERIMENT 1 Experimental verification of parallelogram law	3 Hours
2 EXPERIMENT 2 Experimental verification of Lamis theorem	3 Hours
3 EXPERIMENT 3 Experimental demonstration of principles of moments using bell crank lever apparatus.	4 Hours
4 EXPERIMENT 4 Determination of equilibrant force using polygon law of forces	3 Hours
5 EXPERIMENT 5 Experimental study of equilibrium of forces in concurrent co-planar systems.	4 Hours
6 EXPERIMENT 6 Experimental analysis of the reaction forces of a simply supported beam and compare the same with analytical results.	3 Hours
7 EXPERIMENT 7 Determination of centroid of laminas.	3 Hours
8 EXPERIMENT 8 Determination of moment of inertia of plane area.	3 Hours

9

4 Hours

EXPERIMENT 9

Determination of coefficient of friction between two surfaces.

Total: 60 Hours

Reference(s)

1. F.P. Beer, and Jr. E.R Johnston, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2007
2. N.H.Dubey, Engineering Mechanics- Statics and Dynamics, Tata McGraw-Hill Publishing Company, New Delhi, 2013
3. Irving H. Shames, Engineering Mechanics - Statics and Dynamics, Pearson Education Asia Pvt. Ltd., 2006
4. R.C.Hibbeler, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010.
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005

18ME103 ENGINEERING CHEMISTRY I**2023****Course Objectives**

- To outline the importance and applications of metals and alloys
- To select and fabricate a suitable alloy for a mechanical application
- To choose and identify the elements using analytical 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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the concept of atomic structure and bonds in metallic structure.
2. Apply the concept of phase rule in metal-alloy system.
3. Outline the properties and applications of ferrous and nonferrous alloys.
4. Indicate the importance of heat treatment of steel.
5. Apply suitable analytical methods for the estimation of elements.

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	2												2	
4	2			2										2	
5	3			2										2	

UNIT I**6 Hours****ATOMIC STRUCTURE AND CRYSTALLIZATION**

Atomic structure: Introduction to fundamental concepts - dual nature of the electrons - periodic table - types of atomic interaction (ionic, covalent, coordinate covalent, metallic and Vanderwaals interactions). Metallic crystal structure - ceramic crystal structure - polymer crystal structure.

UNIT II**6 Hours****PHASE RULE**

Phase - component - degree of freedom - solubility limit - Gibbs phase rule - phase diagram - phase equilibrium applications - one component system (water system). Reduced phase rule: Two component systems (lead and silver system and Fe-Fe₃C diagrams).

UNIT III	5 Hours
FERROUS AND NON-FERROUS ALLOYS	
Alloys: Purpose of alloying - function and effects of alloying elements - properties of alloys - classification of alloys. Composition, types, properties and applications of ferrous alloys (Steel, cast iron and stainless steel) & Non-ferrous alloys (Aluminium, copper, magnesium and nickel).	
UNIT IV	7 Hours
HEAT TREATMENT	
Heat treatment of steel: Annealing - stress relief - recrystallization and spheroidizing - normalizing - hardening - tempering of steel - isothermal transformation diagram (TTT diagram) - cooling curves - carburizing - nitriding - cyaniding - carbonitriding - flame and induction hardening.	
UNIT V	6 Hours
SPECTROSCOPY	
Beer-Lamberts law - Electromagnetic spectrum - electronic - vibrational - rotational transitions. Principle - instrumentation (Block diagram) - applications of UV visible - IR spectroscopy. Spectrophotometric estimation of iron (colorimetry).	
FURTHER READING	
Study the composition, properties and applications of different ferrous and non-ferrous alloys. Application of phase rule in mechanical engineering. Importance of analytical techniques for mechanical engineering.	
1	2 Hours
EXPERIMENT 1	
Instruction about safety rules, reagent handling and precautions need to be followed in lab.	
2	4 Hours
EXPERIMENT 2	
Measurement of grain size using optical metallurgical microscope.	
3	4 Hours
EXPERIMENT 3	
Estimation of copper content in brass by EDTA method.	
4	4 Hours
EXPERIMENT 4	
Microstructure analysis of steel/cast iron.	
5	4 Hours
EXPERIMENT 5	
Microstructure analysis of stainless steel	
6	4 Hours
EXPERIMENT 6	
Microstructure analysis of aluminium/copper	
7	4 Hours
EXPERIMENT 7	
Determination of hardenability using Jominy end quench test.	

8

4 Hours

EXPERIMENT 8

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method

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. G.E.Dieter, Mechanical Metallurgy, McGraw Hill, 2007.
3. V.Raghavan, Materials Science and Engineering, Prentice Hall of India, Delhi, 2009.
4. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publisher, New Delhi, 2016.
5. SashiChawla, Text Book of Engineering Chemistry, DhanpatRai Publications, New Delhi, 2013.
6. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, TMH, 2009.

18ME104 BASICS OF ELECTRICAL ENGINEERING**2 0 2 3****Course Objectives**

- To understand the basic concepts of electrical elements and measuring instruments.
- To indicate the electrical properties of material.
- To illustrate the construction and operation of various electrical machines.
- To illustrate the construction and operation of various electrical drives.
- To understand the various components used in electrical installations.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the basic concepts of electrical elements and measuring instruments.
2. Differentiate the various electrical properties of material.
3. Classify the static and dynamic machines and explain their operation.
4. Analyze the operation of electrical drives.
5. Analyze the functions of various components used in electrical systems

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	3	2		1									1		
3	1	1	3										1		
4	2	1		3									1		
5	3	2		1									1		

UNIT I**6 Hours****ELECTRICAL ELEMENTS AND MEASURING INSTRUMENTS**

Resistance, Inductance, Capacitance, Wires and Cables. Ammeter, Voltmeter, Wattmeter, Energy meter, Thermistor and Anemometer.

UNIT II**6 Hours****ELECTRICAL PROPERTIES OF MATERIAL**

Resistivity, Conductivity, Temperature co-efficient, Permittivity and Thermoelectricity. Identification of Materials by conducting resistivity test, Ohms law and Kirchhoff Law.

UNIT III**6 Hours****ELECTRICAL MACHINES**

Construction and operating characteristics: DC Motor, Single Phase Transformer, Three phase

induction motor, Single phase induction motors, Synchronous Motor, and Stepper Motor.

UNIT IV **6 Hours**

ELECTRICAL DRIVES

Components of Electrical Drives, Selection of electric motor for drives, VFD for pumps and fans, Servo motor drive.

UNIT V **6 Hours**

ELECTRICAL INSTALLATIONS

Types of Protection devices: Fuses, MCB, ELCB, equipments for house wiring, simple house wiring and pump motor wiring.

1 **6 Hours**

EXPERIMENT 1

Measure the electric properties of the given material such as resistivity, conductivity, temperature coefficient of resistance, permittivity and thermo electricity. Identify the material by conducting resistivity measurement test.

2 **6 Hours**

EXPERIMENT 2

Development of prototype electrical generator, motor and measure the voltage, speed and torque.

3 **6 Hours**

EXPERIMENT 3

Measure the mechanical input power, electrical output power and efficiency of synchronous generator.

4 **6 Hours**

EXPERIMENT 4

Measure the electrical input power, mechanical output power and efficiency of Variable frequency induction motor drive.

5 **6 Hours**

EXPERIMENT 5

Conduct an experiment to control the speed of stepper motor and servomotor drives.

Total: 60 Hours

Reference(s)

1. T.K.Nagsarkar and M.S.Sukhija, Basic of Electrical Engineering, Oxford University Press, 2011.
2. Laszlo Solymar, Donald Walsh, Richard R. A. Syms, Electrical Properties of materials, Oxford University press, 2014.
3. A. Sudhakar, Shyammoan S Palli, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill, 2010.
4. G.K.Dubey, G, Fundamental of Electrical Drives, Narosa publishing House, New Delhi, 2012.
5. B.L.Theraja, A.K.Theraja, A Text Book of Electrical Technology Volume II, S.Chand and Company Ltd, New Delhi, 2016.
6. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 2014.

18HS101 COMMUNICATIVE ENGLISH I**1 0 2 2****Course Objectives**

- Read and understand the main points on familiar matters regularly encountered in work, school, or leisure
- Listen and respond in most common situations where English is spoken
- Write simple connected texts on topics which are familiar or of personal interest
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans

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.

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Preliminary exam level
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature
3. Write straightforward, routine letters of a factual nature, and make notes on routine matters, such as taking/placing orders
4. Follow simple presentations/demonstrations
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters

Articulation Matrix

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

UNIT I**9 Hours****GRAMMAR**

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II**9 Hours****READING**

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III

9 Hours

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV

9 Hours

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V

9 Hours

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making. 1. Goodbye party for Miss Pushpa T S - Nissim Ezekiel 2. Our Casuarina Tree - Toru Dutt 3 .Palanquin Bearers - Sarojini Naidu 4. The Tyger - William Blake 5. Ode on a Grecian Urn - John Keats

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

18ME106 COMPUTER PROGRAMMING I**0 0 4 2****Course Objectives**

- Understand the basics of C primitives, operators and expressions.
- Gain knowledge about the different primitive and user defined data types.
- Impart knowledge about the structural programming concepts.

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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and Strings.
4. Design applications using structures in C.
5. Apply the concepts of functions in writing C programs.

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			3								3		
3	2	3			3								3		
4	1	3			3								3		
5	1	3			3								3		

1**6 Hours****EXPERIMENT 1**

Implement a C program which include a fundamental data types Integer, Float, Double and Character.

2**6 Hours****EXPERIMENT 2**

Implement a C program to perform the arithmetic operations using primitive data types.

3**6 Hours****EXPERIMENT 3**

Implementation of logical, relational, bitwise, increment/decrement and Conditional Operators in C.

4	3 Hours
EXPERIMENT 4 Implementation of simple if else Conditional Statement.	
5	3 Hours
EXPERIMENT 5 Implementation of nested if else Conditional Statement.	
6	3 Hours
EXPERIMENT 6 Implementation of Switch Case Statement.	
7	3 Hours
EXPERIMENT 7 Implement a C program using for Looping Statement.	
8	3 Hours
EXPERIMENT 8 Implement a C program using Do-While Looping Statement.	
9	3 Hours
EXPERIMENT 9 Implement a C program using While Looping Statement.	
10	3 Hours
EXPERIMENT 10 Implementation of Jumping Statements	
11	3 Hours
EXPERIMENT 11 Implementation of One Dimensional Array.	
12	3 Hours
EXPERIMENT 12 Implementation of Two Dimensional Array.	
13	3 Hours
EXPERIMENT 13 Implement a C program to perform String Manipulation Functions.	
14	6 Hours
EXPERIMENT 14 Implement a C program using structures.	
15	6 Hours
EXPERIMENT 15 Implement a C program which includes four categories of functions and recursive functions.	
Total: 60 Hours	

18ME107 ENGINEERING DRAWING**0 0 4 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

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									1			1		
3	2									1			1		
4	2									1			1		
5	2									1			1		

UNIT I**10 Hours****FUNDAMENTALS OF ENGINEERING DRAWINGS**

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**12 Hours****PROJECTION OF POINTS**

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

10 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.

UNIT IV

12 Hours

SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

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

UNIT V

16 Hours

ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW

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

Total: 60 Hours

Reference(s)

1. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2011.
2. Basant Agrawal, Mechanical drawing, Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards-Sp46, 2008.
4. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.

18ME201 ENGINEERING MATHEMATICS II**3 1 0 4****Course Objectives**

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Illustrate the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems
3. Recognize the differentiation properties of vectors.
4. Identify the complex functions and their mapping in certain complex planes.
5. Use the concepts of integration to complex functions in certain regions.

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		
3	2	1											1		
4	2	1											1		
5	2	1											1		

UNIT I**9 Hours****PARTIAL DIFFERENTIATION**

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II**9 Hours****MULTIPLE INTEGRALS**

Double integrals, regions of integration, triple integrals, applications (Cartesian coordinates only- Greens theorem and Gauss Divergence theorem).

UNIT III**9 Hours****ANALYTIC FUNCTIONS**

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV

9 Hours

FIRST ORDER DIFFERENTIAL EQUATIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoulli's equation, applications.

UNIT V

9 Hours

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill Publishing Company Ltd, 2003.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015.
3. J. A. Brown and R. V. Churchill, Complex Variables and Applications, Sixth Edition, McGraw Hill, New Delhi, 1996.
4. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2014.
5. Glyn James, Advanced Engineering Mathematics, Third Edition, Wiley India, 2014.

18ME202 ENGINEERING PHYSICS II - DYNAMICS**2 1 0 3****Course Objectives**

- Impart knowledge in kinematics of particles
- Familiarize the basic concepts of force, mass and acceleration
- Determine the nature of force associated with work and energy
- Summarize the motion of rigid bodies
- Solve the realistic problems related to rigid body kinetics

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Determine the solution for the problems related to kinematics of particles.
2. Evaluate the relation existing among force, mass and acceleration of particles.
3. Calculate forces associated with work, energy, impulse and momentum.
4. Analyze the geometric motion of rigid bodies.
5. Apply the concepts of rigid body kinetics to solve engineering problems.

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****KINEMATICS OF PARTICLES**

Introduction to dynamics Rectilinear motion displacement, velocity and acceleration Equations of motion Curvilinear motion angular displacement, velocity and acceleration. Types of coordinates system rectangular, tangential and normal.

UNIT II**6 Hours****KINETICS OF PARTICLES I: FORCE, MASS AND ACCELERATION**

Introduction to kinetics Newton second law of motion Equations of motion Problems on rectangular coordinates, normal and tangential components. Dynamic equilibrium Alembert principle.

UNIT III**6 Hours****KINETICS OF PARTICLES II: WORK ENERGY AND IMPULSE MOMENTUM**

Principle of work conservative and non-conservative forces. Principle of energy potential energy, kinetic energy, conservation of energy. Principles of Impulse and Momentum principle of conservation of linear momentum. Impact direct, central, non-central, oblique coefficient of restitution.

UNIT IV

6 Hours

PLANE KINEMATICS OF RIGID BODIES

Introduction to planar kinematics Types of motion Rectilinear and curvilinear Translation motion, Rotational motion about a fixed axis, General plane motion Absolute and relative velocity Instantaneous centre of rotation and acceleration.

UNIT V

6 Hours

PLANAR KINETICS OF RIGID BODIES

Introduction to 2-D kinetics Force and Acceleration General equations of motion. Principle of work and Energy work done by a couple, spring principle of conservation of energy. Principle of impulse and momentum linear momentum.

Tutorial: 15 Hours

Total: 45 Hours

Reference(s)

1. Beer, Johnston, Mazurek, Cornwells and Sanghi, Vector Mechanics for Engineers: Statics, Dynamics, 10th Edition, Tata McGraw Hill Noida, Uttar Pradesh, 2013.
2. N.H. Dubey, Engineering Mechanics Statics and Dynamics, First Edition, McGraw-Hill Education India Private Ltd., New Delhi, 2012.
3. R.C. Hibbeler, Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2012.
4. J.L. Meriam and L.G. Kraige, Engineering Mechanics: Dynamics, 7th Edition, Wiley India Private Limited, 2013.
5. Irving H. Shames, Engineering Mechanics Statics and Dynamics, 4th Edition, Pearson India, 2011.
6. www.nptel.iitm.ac.in/video.php?subjectId=122104015.

18ME203 ENGINEERING CHEMISTRY II**2023****Course Objectives**

- To understand the importance of electrochemistry in batteries and corrosion control.
- To realize the structure property relationship with properties of polymers.
- To identify the utility of smart materials in engineering 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems.
2. Analyze the type of corrosion, factors influencing rate of corrosion on metals and identify a suitable corrosion control method.
3. Realize the importance of polymers based on its source, properties and applications.
4. Recognize the applications of glass, ceramics, cement, abrasives and refractories in engineering applications.
5. Identify the properties and applications of composites and smart materials.

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										2	
3	2		2											2	
4	2		2	1										2	
5	2		2	1										2	

UNIT I**6 Hours****ELECTROCHEMISTRY**

Electrodes Electrode potential (single & standard electrode potential). Cells: half cell cell reactions cell representation types (difference between electrochemical and electrolytic cells). Types of electrodes Calomel electrode determination of single electrode potential electrochemical series and its importance and ion-selective electrode (glass electrode measurement of pH using glass electrode). Batteries: Difference between cell and a battery Primary and secondary batteries Construction and working of Lead acid and Lithium battery.

UNIT II**6 Hours****CORROSION SCIENCE**

Corrosion: types of corrosion: chemical (types of oxide layer: stable, unstable, volatile and porous, Pilling-Bedworth rule) and electrochemical corrosion (hydrogen evolution and oxygen absorption mechanism). Types of electrochemical corrosion: Galvanic corrosion and differential aeration corrosion (pitting, stress, waterline and pipeline). Galvanic series and its applications. Factors influencing corrosion rate. Corrosion control methods: Sacrificial anode and impressed current cathodic protection. Metallic coating (galvanizing and tinning).

UNIT III**6 Hours****STRUCTURE, CHARACTERISTICS AND APPLICATION OF POLYMERS**

Monomers polymers polymerization functionality degree of polymerization classification of polymers polymer molecular weight. Types of polymerization: addition, condensation and copolymerization. Structure, properties and applications of thermosetting (epoxy resin and alkalite) and thermoplastics (polyvinyl chloride and polytetrafluoroethylene). Compounding of plastics injection and extrusion moulding.

UNIT IV**7 Hours****ENGINEERING MATERIALS**

Glass and ceramics: Types and properties of glass and ceramic materials. Portland cement: Properties setting and hardening of cement special cement water proof and white cement properties and uses. Abrasives: Definition Moh scale of hardness classification of abrasives natural abrasives artificial abrasives (silicon carbide and boron carbide). Refractories : Definition classification properties of refractories preparation, properties and uses of high alumina bricks, magnesite and zirconia bricks.

UNIT V**5 Hours****ADVANCED MATERIALS**

Composites: Introduction to composites classification, properties, application and morphology of fibre reinforced composites, metal matrix composites and ceramic composites. Smart material: Introduction to smart materials, properties and applications of shape memory alloys and phase changing materials.

1**6 Hours****EXPERIMENT 1**

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode and Preparation of 1N oxalic acid and 1M sodium carbonate solutions

2**4 Hours****EXPERIMENT 2**

Determination of strength of hydrochloride acid present in the given solution by pH measurement.

3**4 Hours****EXPERIMENT 3**

Determine the strength of mixtures of acid using a conductivity cell.

4**4 Hours****EXPERIMENT 4**

Measurement of rate of corrosion on Zinc/mild steel in aerated/ neutral/ acidic/ alkaline solution by weight loss method.

5**4 Hours****EXPERIMENT 5**

Determination of molecular weight of a polyvinyl alcohol using Ostwald viscometer.

6

4 Hours

EXPERIMENT 6

Testing of thermal stability of polymer using TGA Analyzer.

7

4 Hours

EXPERIMENT 7

Determination of molecular structure of given sample using FTIR spectroscopy.

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. G.E. Dieter, Mechanical Metallurgy, McGraw Hill, 2007.
3. V.Raghavan, Materials Science and Engineering, Prentice Hall of India, Delhi, 2009
4. P.C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publisher, New Delhi, 2016.
5. Sashi Chawla, Text Book of Engineering Chemistry, Dhanpat Rai Publications, New Delhi, 2013.
6. J.C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, TMH, 2009.

18ME204 BASIC ELECTRONICS ENGINEERING**2023****Course Objectives**

- To understand the basic concepts of semiconductor diodes and transistors.
- To illustrate the construction and operation of feedback amplifiers and oscillators.
- To learn the fundamentals of operational amplifiers and digital electronics.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the diodes in rectifier and regulator applications and also analyze its performance.
2. Simplification of Boolean expressions using K-map and implementation of combinational & sequential circuits.
3. Illustrate the working of analog IC with different configurations and analyze its characteristics.
4. Apply special electronics devices in circuit design.
5. Interface DC, servo, stepper motor with electronic devices.

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	1	1	3										2		
4	2	1		3									2		
5	3	2		1									2		

UNIT I**6 Hours****ELECTRONIC DEVICES**

Diode construction and working, application of diode, clipper, clamper and rectifier. BJT-construction and working, BJT as switch and amplifier. CRO, Function generator, multimeter and power supply.

UNIT II**6 Hours****DIGITAL CIRCUITS**

Number system, Boolean theorem, logic gates, Simplification of logic function, Combinational circuits- Adder, subtractor, Encoder, decoder, multiplexer, demultiplexer. Sequential circuits-latch, flip-flop, counter.

UNIT III ANALOG ICs Op-Amp (IC 741) - characteristics, application of Op-Amp adder, subtractor, comparator, ADC and DAC. Timer - (555) Astable and monostable multivibrator.	6 Hours
UNIT IV SPECIAL ELECTRONIC DEVICES Introduction to Op-Amp, Differential Amplifier Configurations, CMRR, PSRR, Slew Rate; Block Diagram, Pin Configuration of 741 Op-Amp, Characteristics of Ideal Op-Amp, Concept of Virtual Ground.	6 Hours
UNIT V INTERFACING ACTUATORS Interfacing DC motor with electronic devices, Interfacing SERVO motor with electronic devices, Interfacing stepper motor with electronic devices.	6 Hours
1 EXPERIMENT 1 Design of regulated power supply. (5v,9v, 12v)	6 Hours
2 EXPERIMENT 2 BJT as switch and amplifier in Automatic Street light.	6 Hours
3 EXPERIMENT 3 Combinational circuit as adder, subtractor, encoder, decoder in vending machine.	6 Hours
4 EXPERIMENT 4 Sequential circuit as counter in water level controller.	6 Hours
5 EXPERIMENT 5 Application of op-Amp in measurement of temperature.	6 Hours
Total: 60 Hours	
Reference(s) <ol style="list-style-type: none">1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India2. J Millman, C. Halkias & Satyabrata JIT, Electronic Devices and Circuits, Tata McGraw-Hill, 2010.3. S. Salivahanan, N.Suresh Kumar and A.Vallavaraj, Electronic Devices and Circuits, Tata McGraw-Hill Education, 20084. D. Roy Choudhry, Shail Jain Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.5. M. Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.	

18ME205 MANUFACTURING PROCESSES**2023****Course Objectives**

- To study the sand casting and special casting processes sand casting processes and practice mould preparation
- To learn various metal joining processes and gain welding skills.
- To provide the knowledge on various bulk deformation processes and its applications.
- To expose knowledge on sheet metal forming processes and special forming processes and to make small sheet metal parts.
- To learn about the various plastics moulding and forming processes and to make simple plastic part.

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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Choose the suitable casting process to produce the simple casting components and prepare mould with core
2. Select the suitable welding equipment and weld the given material.
3. Select the suitable bulk deformation process based on application.
4. Explain the sheet metal forming processes and make simple sheet metal components.
5. Identify the suitable moulding and forming processes of plastics for produce simple plastic parts

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	2					1		1	1				2	
3	2	2												2	
4	2	2							1	1				2	
5	2	2							1	1				2	

UNIT I

6 Hours

CASTING PROCESSES

Introduction to production processes and its classifications - Pattern Types and Allowances. Moulding sand - Types, Properties and Testing. Moulding machines and its types. Melting furnaces - Induction, Fettling and cleaning. Sand casting defects. Special casting processes - Die casting, Centrifugal casting and Investment casting

UNIT II

7 Hours

METAL JOINING PROCESSES

Introduction to welding processes and its classifications - Principle of Gas welding and its flames - Principle of arc welding. Principle of Resistance welding - Spot, butt and seam. Principle of Gas metal arc welding, Submerged arc welding, Tungsten Inert Gas welding, Plasma arc welding, Thermit welding, Electron beam welding and Friction welding -Six weld defects - Brazing and soldering.

UNIT III

6 Hours

BULK DEFORMATION PROCESSES

Introduction - Hot and cold working of metals - Forging processes - Open and close die forging, Forging equipment and operations. Rolling-Types of Rolling mills, shape rolling operations, Tube piercing and Defects. Principle of Extrusion and its types. Principle of rod and wire drawing.

UNIT IV

5 Hours

SHEET METAL FORMING AND SPECIAL FORMING PROCESSES

Introduction - Shearing, bending and drawing operations - Stretch forming operations - Principle of special forming processes - Hydro forming, Rubber pad forming, Metal spinning, Explosive forming, Magnetic pulse forming, Peen forming and Super plastic forming.

UNIT V

6 Hours

MOULDING AND FORMING OF PLASTICS

Introduction to plastics - Moulding of Thermoplastics - Principle and applications of Injection moulding and its types, Blow moulding, Rotational moulding, Thermoforming and Extrusion. Moulding of Thermosets - Principle and applications of Compression moulding and Transfer moulding - Bonding of Thermoplastics - Fusion and solvent methods.

1

3 Hours

EXPERIMENT 1

To demonstrate the various patterns used in sand casting and prepare a mould using split pattern in sand casting process.

2

3 Hours

EXPERIMENT 2

Casting of aluminium components

3

3 Hours

EXPERIMENT 3

Fabrication of simple structural shapes using manual Metal Arc Welding

4

3 Hours

EXPERIMENT 4

Fabrication of simple structural shapes using TIG and MIG welding

5	3 Hours
EXPERIMENT 5	
Manufacturing of Simple sheet metal components using shearing and bending operations	
6	3 Hours
EXPERIMENT 6	
Drawing of cup shaped product	
7	3 Hours
EXPERIMENT 7	
To make a simple thermoplastic component using injection Moulding	
8	3 Hours
EXPERIMENT 8	
To make a simple component using compression Moulding	
9	3 Hours
EXPERIMENT 9	
Extrusion of rod drawing	
10	3 Hours
EXPERIMENT 10	
To make a pet bottle using Blow Moulding	

Total: 60 Hours

Reference(s)

1. P.N. Rao, Manufacturing Technology vol. I, Tata McGraw-Hill Publishing Company Private Limited, New Delhi, 2010.
2. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Education Limited, New Delhi, 2013.
3. J.P. Kaushish, Manufacturing Processes, Prentice Hall of India Learning Private Limited, New Delhi, 2013.
4. P.C. Sharma, Manufacturing Technology - I, S Chand and Company Private Limited, New Delhi, 2010.
5. S.K. Hajra Choudhury, Elements of Workshop Technology - Vol. I, Media Promoters & Publishers Private Limited, Mumbai, 2013
6. <http://nptel.ac.in/courses/112107144/1>

18ME206 COMPUTER PROGRAMMING II**0 0 4 2****Course Objectives**

- To understand the basics of C++ and Java primitives, operators, and expressions, conditional and looping statements.
- To understand and apply the concepts of classes, inheritance, interfaces and packages.
- To develop programs using Strings and exception handling.

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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Implement C++ and java programs using data types, operators, arrays, control and looping statements.
2. Apply class, objects, methods and inheritance in C++.
3. Develop java programs using the concepts of its basic primitives, class and methods.
4. Design applications using inheritance, interface and package.
5. Apply the concepts of strings and exception handling.

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			3								3		
3	2	3			3								3		
4	1	3			3								3		
5	1	3			3								3		

1**3 Hours****EXPERIMENT 1**

Working with basic data types and arrays.

2**3 Hours****EXPERIMENT 2**

Implementation of control statements.

3**3 Hours****EXPERIMENT 3**

Implementation of looping statements.

4	3 Hours
EXPERIMENT 4 Implementation of class and objects.	
5	3 Hours
EXPERIMENT 5 Working with constructor and destructor.	
6	3 Hours
EXPERIMENT 6 Implementation of types of Inheritance.	
7	3 Hours
EXPERIMENT 7 Working with call by value and call by reference.	
8	3 Hours
EXPERIMENT 8 Implementation of friend function.	
9	3 Hours
EXPERIMENT 9 Implementation of overloading.	
10	3 Hours
EXPERIMENT 10 Working with basic data types, static variables and arrays.	
11	6 Hours
EXPERIMENT 11 Program on Classes and objects.	
12	6 Hours
EXPERIMENT 12 Working with Methods.	
13	6 Hours
EXPERIMENT 13 Implementation of Inheritance.	
14	6 Hours
EXPERIMENT 14 Implementation of Overloading and Overriding.	
15	6 Hours
EXPERIMENT 15 Implementation of Packages.	
Total: 60 Hours	

18ME301 ENGINEERING MATHEMATICS III**3 1 0 4****Course Objectives**

- To gain knowledge on Fourier series and Laplace transform through practical applications.
- To understand the concepts of Fourier series and Boundary conditions, which will enable them to model and analyze the physical phenomena.
- To develop the foundations of probabilistic and statistical analysis mostly used in varied applications in Mechanical engineering

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Develop Fourier series for different types of functions.
2. Derive and obtain the solution of wave, heat equation and boundary value problems.
3. Analyze and solve engineering problems using Laplace Series.
4. Apply the concepts of probability distributions in an appropriate place of science and Engineering.
5. Apply different statistical process control charts.

Articulation Matrix

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

UNIT I**9 Hours****FOURIER SERIES**

Introduction-periodic functions- properties, even and odd functions- special wave form: square wave, half wave rectifier, full wave rectifier, saw-toothed wave and triangular wave - Eulers formulae for full range Fourier series, Fourier series for functions of period $2l$ -Dirichlets conditions - sum of Fourier series- Theorem for the convergence of Fourier series (statement only)- Fourier series of a function with its periodic extension - Half range Fourier series: construction of half range sine series, construction of half range cosine series. Parsevals identity (statement only).

UNIT II**9 Hours****APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**

Classification of partial differential equations of second order-solution of: one dimensional wave equation, one dimensional heat equation, two dimensional heat equation and vibration of circular membrane.

UNIT III

9 Hours

LAPLACE TRANSFORM

Laplace Transform: Applications, advantages and sufficient conditions for existence of Laplace transform- general properties of Laplace transform-Laplace transform of periodic function. Inverse Laplace Transform: general properties of inverse Laplace transform - use of partial fraction method to find of inverse Laplace transform - convolution -application of Laplace transform to differential equations with constant coefficients.

UNIT IV

9 Hours

PROBABILITY THEORY

Probability: Classical definition and its limitations- axiomatic definition-some elementary deduction-frequency interpretation of probability -addition rule for 2 events (proof) and its extension to more than 2 events (statement only)- conditional probability and independent events -extension to more than 2 events (pairwise and mutual independence)- multiplication rule-Bayes theorem (statement only). Random variables: Definition of random variable- continuous and discrete random variables-probability density function & probability mass function for single variable only- distribution function and its properties (without proof)- definitions of expectation and variance, properties- some important discrete distributions: Binomial & Poisson distributions.

UNIT V

9 Hours

MATHEMATICAL STATISTICS

Population and sample - Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses - one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Kreyszig Erwin, Advanced Engineering Mathematics, 7th Edition, John Wiley, 1993.
2. Johnson Richard A. and Bhattacharyya Gouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996
3. O'Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995

18ME302 FLUID MECHANICS AND MACHINERY**2 1 2 4****Course Objectives**

- To impart knowledge on the properties of fluid and fluid statics principles
- To calculate the rate of flow and energy losses in flow through pipes.
- To emphasise the concepts of boundary layer theory and the importance of dimensional analysis
- To educate the working principles and performance analysis of fluid pumps.
- To provide knowledge on the working principle and performance curves of hydraulic 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.

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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the fluid properties and the pressure measurement using fundamental laws of fluid mechanics
2. Analyse the volume rate of flow and losses occur in a flow through pipes.
3. Apply the concept of boundary layer, Dimensional analysis and Modal analysis on the fluid structures
4. Select a suitable pump for a given application and evaluate the operating characteristics of Hydraulic pumps
5. Select a suitable turbine for a given application and evaluate the operating characteristics of Hydraulic turbines

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	3	3		2						2					2
3	3	2		2						2					2
4	2	2		2						2					2
5	2	2		2						2					2

UNIT I**6 Hours****FLUID PROPERTIES AND FLUID STATICS**

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Types of fluids, Types of fluid flow. Fluid statics-Fluid pressure at a point, Variation of pressure with a static fluid, Hydrostatic law Pressure head, Pascal's law, Measurement of pressure, Piezometric tube Manometry

UNIT II FLUID KINEMATICS AND DYNAMICS Concept of control volume - continuity equation, Bernoulli's equation and its applications-Momentum Equation- Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli Darcy Weisbach equation friction factor- Moody diagram- commercial pipes- minor losses- Flow through pipes in series and parallel.	6 Hours
UNIT III FLUID FLOW OVER BODIES AND DIMENSIONAL ANALYSIS Boundary layer concepts-Types of boundary layer thickness -Lift and Drag of an aerofoil -Need for dimensional analysis -Methods of dimensional analysis using Buckingham pi theorem -Similitude - Types of similitude-Dimensionless parameters-Application of Dimensionless parameters-Model Analysis.	6 Hours
UNIT IV HYDRAULIC PUMPS Euler's equation - Theory of roto-dynamic machines-Centrifugal pumps working principle- velocity triangle -work done by the impeller - performance curves - Reciprocating pump- working principle Rotary pumps -classification.	6 Hours
UNIT V HYDRAULIC TURBINES Classification of turbines heads and efficiencies velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles work done by water on the runner draft tube. Specific speed unit quantities performance curves for turbines.	6 Hours
1 EXPERIMENT 1 Visualize the flow using Reynolds apparatus	2 Hours
2 EXPERIMENT 2 Verification of Bernoulli's theorem and Determine the coefficient of discharge using Venturimeter	4 Hours
3 EXPERIMENT 3 Determination of friction factor for a given set of pipes	3 Hours
4 EXPERIMENT 4 Determine the coefficient of discharge for a rotometer and orificemeter	3 Hours
5 EXPERIMENT 5 Determination of lift and drag force of an aerofoil.	3 Hours
6 EXPERIMENT 6 Performance test on tangential flow impulse turbine against constant head.	3 Hours

7 **3 Hours**

EXPERIMENT 7

Performance test on Francis turbine against constant head

8 **3 Hours**

EXPERIMENT 8

Performance test on reaction (Kaplan) turbine

9 **3 Hours**

EXPERIMENT 9

Performance test on centrifugal pump.

10 **3 Hours**

EXPERIMENT 10

Performance test on submersible pump/Gear pump.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. Yunus A. Cengel, and John M. Cimbala, Fluid Mechanics, Third edition, Mc Graw Hill Education (India) Pvt. Ltd, 2014.
2. Dr R.K. Bansal , A text book of Fluid Mechanics and Hydraulic Machines, Tenth Edition, Laxmi Publications, 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/>.

18ME303 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Exemplify the basic concepts and zeroth law of thermodynamics
2. Apply the first law of thermodynamics to closed and open systems
3. Solve the problems related to cycles and cyclic devices using second law of thermodynamics
4. Determine the thermodynamic properties of pure substances and its phase change processes
5. Evaluate the air standard performance of heat engines and properties of gas mixtures

Articulation Matrix

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

UNIT I**8 Hours****INTRODUCTION AND ZEROth LAW OF THERMODYNAMICS**

Macroscopic and Microscopic approaches, Definitions and concepts- heat, work, thermodynamic equilibrium, system and types, surroundings, Properties- intensive and extensive properties, Path and point functions, Energy- macroscopic and microscopic modes of energy, Thermodynamic processes and cycle, State postulate, Zeroth law of thermodynamics- temperature scale, perfect gas scale.

UNIT II**10 Hours****FIRST LAW OF THERMODYNAMICS**

First law of thermodynamics, first law for Closed systems - constant pressure process, constant volume process, constant temperature process, adiabatic process, polytropic process, throttling process. First law for open systems -Steady state flow processes, Steady flow energy equation (SFEE), Application of SFEE-turbines and compressors, nozzles and diffusers, throttling valves, heat exchangers

UNIT III**8 Hours****SECOND LAW OF THERMODYNAMICS**

Limitations of first law of thermodynamics, Second law of thermodynamics- Kelvin - Planck and Clausius statements, Heat Engine, heat pump and refrigerator, Reversibility and irreversibility- irreversible and reversible processes, Carnot's principles, Carnot cycle, Carnot engine, Thermodynamic temperature scale, Clausius inequality, Entropy- principle of entropy increase, Availability & irreversibility.

UNIT IV**9 Hours****PROPERTIES OF PURE SUBSTANCES**

Thermodynamic properties of fluids. Pure substance-phases - Phase change processes, Property diagrams - pressure-volume (P-v), pressure-temperature (P-T), temperature volume (T-v), temperature-entropy (T-s) and enthalpy-entropy (h-s) diagrams. Steam tables - Problems on flow and non-flow processes. Ideal gas - equation of state, Van der Waals equation and compressibility chart.

UNIT V**10 Hours****GAS MIXTURES AND GAS POWER CYCLES**

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

FOR FURTHER READING

Thermodynamic property relations- Maxwell relations, TDS equations, The Clapeyron equation, Joule-Thompson expansion.

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, 2011.
2. P.K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2017.
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, December 31st 1978, John Wiley & Sons.
6. https://onlinecourses.nptel.ac.in/noc18_ae05/preview.

18ME304 MANUFACTURING TECHNOLOGY**2023****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 of centre, semi-automatic, automatic lathes. Also gain basic working skills for making simple components in centre and semi automatic lathe.
- To provide working skill and knowledge on construction and working of milling and gear cutting machines.
- To impart the knowledge on working of reciprocating, drilling, boring machines and provide working skill in slotting and drilling machines.
- To familiarize about the construction and working of broaching, grinding, fine finishing processes and to provide working skills in grinding machines

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

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 type of lathe machine based on the application and make simple components using lathe machines.
3. Identify and explain the suitable type of milling & gear cutting machines for the given components and produce simple components using these machines.
4. Choose the suitable reciprocating & drilling machine for the production of components and make simple components using these machines.
5. Identify and explain the suitable finishing process based on the application and produce simple components using grinding machines .

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3					1		2	1		1		2	
2	2	3							2	1		1		2	
3	2	2							2	1		1		2	
4	2	2							2	1		1		2	
5	2	2						56	2	1		1		2	

UNIT I **7 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 **6 Hours**

LATHE, SEMI AUTOMATS AND AUTOMATS

Introduction - Types- Centre Lathe - Construction, specification, operations. Mechanisms - Thread cutting. Work holding devices - Centres, chucks, carrier and catch plate and face plates. Calculation of machining time. Capstan and turret lathes - Introduction and turret indexing mechanism. Automats - single spindle, multi spindle and their types.

UNIT III **6 Hours**

MILLING MACHINE AND GEAR CUTTING MACHINES

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 IV **6 Hours**

RECIPROCATING MACHINES, DRILLING AND BORING MACHINES

Shaper, Planer and Slotter - Introduction, types, specification and crank and slotted link quick return mechanisms. Drilling - Introduction, types, specifications, construction of universal drilling machine, types of drills and nomenclature of twist drill. Introduction to horizontal boring machine.

UNIT V **5 Hours**

BROACHING AND FINISHING PROCESSES

Broaching - Introduction and types. Finishing processes - Grinding -Introduction and Types. grinding wheel- selection, glazing, loading, dressing and truing. Fine finishing processes - Honing, lapping, buffing and super finishing.

1 **3 Hours**

EXPERIMENT 1

Measurement of cutting forces acting on the tool during turning operation using dynamometer.

2 **3 Hours**

EXPERIMENT 2

Exercise on step turning using orthogonal and oblique cutting tool.

3 **3 Hours**

EXPERIMENT 3

Exercise on grooving, thread cutting and boring using centre lathe

4 **3 Hours**

EXPERIMENT 4

Exercise on turning, drilling and tapping using capstan lathe.

5 **3 Hours**

EXPERIMENT 5

Machining of Pentagonal/Hexagonal/octagonal sides from cylindrical work piece using Milling

machine

6 **3 Hours**

EXPERIMENT 6

Preparation of spur gear from cylindrical work piece using gear hobbing machine.

7 **3 Hours**

EXPERIMENT 7

Machining an internal key way using Slotter machine.

8 **3 Hours**

EXPERIMENT 8

Exercise on drilling and tapping operation using drilling machine.

9 **3 Hours**

EXPERIMENT 9

Machining a metal flat using surface grinding machine.

10 **3 Hours**

EXPERIMENT 10

Machining a shaft using cylindrical grinding machine.

Total: 60 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. P.C Sharma, Manufacturing Technology - II, S. Chand & Company Limited. New Delhi, 2012.
6. <http://nptel.ac.in/courses/112105126/1>

18ME305 KINEMATICS OF MACHINES**3 1 0 4****Course Objectives**

- To impart the knowledge on the concept of simple mechanisms.
- To provide knowledge on kinematic analysis of simple mechanisms.
- To study and construct the cam profile for the various types of follower motion.
- To learn the kinematics terminologies of spur gear and calculate speed ratio of various types of gear train.
- To introduce the concept of friction drives in kinematic of machines.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify the simple mechanisms based on given application.
2. Find velocity and acceleration of simple mechanisms.
3. Construct the cam profile for different types of follower motion.
4. Identify the kinematic terminologies of spur gear and calculate speed ratio of various types of gear train.
5. Estimate the amount of power transmitted by friction drive.

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	1										2	1		
3	1	2										2	1		
4	3	2										2	1		
5	2	2										2	1		

UNIT I**9 Hours****FUNDAMENTALS OF MECHANISMS**

Basic Terminology - Kinematic link, Pair, joints, Structure, Machine, Degree of freedom, Grubler & Kutzbach Criterion - Inversions of four bar mechanism, Mechanical advantage - Transmission Angle, Inversion of single slider and double slider crank mechanisms.

UNIT II**9 Hours****KINEMATIC ANALYSIS OF MECHANISMS**

Relative velocity of kinematic link, Rubbing Velocity of kinematic pair, Coriolis component of Acceleration. Construction of velocity and acceleration diagram by graphical method (Relative Velocity Method), Four bar mechanism, slider crank mechanisms and complex mechanism.

UNIT III

9 Hours

CAM AND FOLLOWER MECHANISMS

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

UNIT IV

9 Hours

GEAR AND GEAR TRAIN

Gears - Terminology, Law of gearing, Length of path of contact, Length of arc of contact, contact ratio. Gear trains- Speed ratio, train value. Simple gear train, compound gear train, Epicyclic gear train- speed calculation by tabular method.

UNIT V

9 Hours

FRICTION DRIVES

Introduction-Friction clutch, types -single plate and Multi plate clutch. Flat Belt Drives Velocity, slip, creep and Centrifugal effect of belt, length of open and cross belt drives, Maximum power transmitted, ratio of driving tension in flat belt drives - V Belt drives.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. S.S Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2014.
2. J. J. Uicker, G. R. Pennock and J. E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, New York, 2011
3. Sadhu Singh, Theory of Machines, Second Edition, Pearson Education, 2012.
4. Ballaney P L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi, 2005.
5. Rao J S and Duggipati, Mechanism and Machine Theory, Wiley- Eastern Ltd., New Delhi, 2006.
6. <https://nptel.ac.in/courses/112104121/1>

18ME306 MACHINE DRAWING LABORATORY**1 0 2 2****Course Objectives**

- To provide knowledge on reading of machine drawing with Geometric Dimensioning and Tolerancing (GD & T)
- To familiarize the representation of various machine element drawings
- To impart the significance of sectional views and its representation in drawings
- To provide knowledge on assembly drawings of mechanical supporting components
- To develop skill to draw the assembly drawings of machine tool and automobile components

Programme Outcomes (POs)

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

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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Describe the basics of machine drawing and GD&T.
2. Represent the machine elements in industrial drawings.
3. Explain the concept of sectional views in drawings.
4. Draw the sectional views of mechanical supporting components.
5. Sketch the assembly drawings of machine tool and automobile components.

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					2		2		2			1		
3	2					2		2		3			1		
4	3					3		3		3			1		
5	3					3		3		3			1		

UNIT I**5 Hours****INTRODUCTION TO MACHINE DRAWING AND GD**

Importance of Machine Drawing - BIS-SP 46 Drawing codes - Classification of Machine Drawings: Assembly drawing, production drawing, detailed drawing, catalogues drawing, patent drawing - Geometric constraint and symbols - Fundamentals of Limits, Tolerances, Fits, surface roughness and its indication in drawings - Elementary weld symbols

UNIT II**5 Hours****REPRESENTATION OF MACHINE ELEMENTS**

Representation of hexagonal bolt and nut - Forms and proportions of rivet heads: chain and zigzag type - Representation of screws, taper keys, pins.

UNIT III

8 Hours

INTRODUCTION OF SECTIONAL VIEWS

Sectional views: cutting plane and its representation, hatching of sections, full section, half section, local sections, revolved sections, thin sections - Sectional views of single parts: pedestal bearing, shaft support, bracket

UNIT IV

12 Hours

ASSEMBLY DRAWINGS OF MECHANICAL SUPPORTING COMPONENTS

Reading of detailed drawings: Bill of materials, Assembly concept, sectional views of assembled drawings - Joint: Strap joint with Gib and Cotter - Coupling: Unprotected type flanged coupling - Gland and stuffing box.

UNIT V

15 Hours

ASSEMBLY DRAWINGS OF MACHINE COMPONENTS

Machine tool parts: Screw jack, Plummer block, Machine Vice, Tail stock - Automobile component: Piston and connecting rod of Petrol engine.

Total: 45 Hours

Reference(s)

1. Gary R. Bertoline, Eric N. Wiebe, Technical Graphics Communication, IR WIN Graphic Series, 4th edition, Tata McGraw Hill, 2017
2. Brian Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2012
3. N.D. Bhatt, Machine Drawing, Charotar Publishing House Pvt. Ltd., 2014
4. K.R. Gopalakrishna, Machine Drawing, Subash stores, 20th edition, 2012
5. <https://nptel.ac.in/syllabus/112106075/>

18ME307 COMPUTER AIDED MODELLING LABORATORY I

0 0 4 2

Course Objectives

- To provide knowledge and skills to draw orthographic projections of simple components using geometric modeling software
- To impart knowledge for creating three dimensional assembly models of few automotive and machine components using CAD Software.
- To provide knowledge on generating 3D assembly models of few machine elements using CAD software.
- To provide knowledge on three dimensional model of simple mechanism and animation using CAD software.
- To expose the knowledge to prepare the technical documents for the given components using software.

Programme Outcomes (POs)

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. To provide knowledge and skills to draw orthographic projections of simple components using geometric modeling software.
2. To impart knowledge for creating three dimensional assembly models of few automotive and machine components using CAD Software
3. To provide knowledge on generating 3D assembly models of few machine elements using CAD software
4. To provide knowledge on three dimensional model of simple mechanism and animation using CAD software
5. To expose the knowledge to prepare the technical documents for the given components using software.

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	1			2		
4					3				2	1			2		
5					3				2	1			2		

1

6 Hours

EXPERIMENT 1

Create an orthographic view of machine components from the given isometric drawings.

2	6 Hours
EXPERIMENT 2	
Construct a three dimensional assembly model of bearing.	
3	6 Hours
EXPERIMENT 3	
Generate a three dimensional shaft and coupling assembly model by considering tolerance in each Component.	
4	6 Hours
EXPERIMENT 4	
Create a three dimensional assembly model of Piston and Connecting Rod.	
5	6 Hours
EXPERIMENT 5	
Build a three dimensional assembly model of power drive system.	
6	6 Hours
EXPERIMENT 6	
Create a three dimensional assembly model of two wheeler suspension system.	
7	6 Hours
EXPERIMENT 7	
Construct a three dimensional assembly model of control valve.	
8	6 Hours
EXPERIMENT 8	
Generate a three dimensional assembly model of Jig/fixture.	
9	6 Hours
EXPERIMENT 9	
Create a three dimensional assembly model of simple mechanism and animate its working using modeling software.	
10	6 Hours
EXPERIMENT 10	
Create technical documents for an I.C engine assembly using 3D via software.	

Total: 60 Hours

Reference(s)

1. Creo Parametric 2.0 for Engineers and Designers, Prof Sham Tickoo, Prabhakar Singh.
2. Geometric Modelling: Theoretical and Computational Basis towards Advanced CAD Applications, Fumihiko Kimura.

18GE301 SOFT SKILLS - VERBAL ABILITY**0 0 2 0****Course Objectives**

- To help students gain adequate proficiency in vocabulary
- To read and understand unabridged text
- To help students become proficient in basic writing skills related to work place communication

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.

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.

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

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

UNIT I**15 Hours****INTRODUCTION**

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II**15 Hours****BASICS OF VERBAL APTITUDE**

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors - Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours**Reference(s)**

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press, 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books, 1991.
3. Baron's The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

18ME401 NUMERICAL METHODS**3 1 0 4****Course Objectives**

- To analyze a mathematical problem and determine which numerical technique to use to solve it.
- To understand the methods to solve polynomial equations and implement the mathematical ideas for interpolation numerically
- To summarize and apply the methodologies involved in solving problems related to ordinary and partial differential 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Compute the errors; apply the numerical methods to solve nonlinear equations and system of equations.
2. Analyze the Finite difference -Forward and backward difference table.
3. Understand numerical differentiation and integration .
4. Determine numerical solutions of ordinary differential equations.
5. Evaluate partial differential equations using numerical techniques.

Articulation Matrix

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

UNIT I**9 Hours****APPROXIMATION**

Approximation in numerical computation: Truncation and rounding errors- fixed and floating-point arithmetic - propagation of errors. Numerical solution of algebraic equations: Bisection method - Regula-Falsi method - Newton-Raphson method. Numerical solution of a system of linear equations: Gauss elimination method - Matrix inversion- LU Factorization method - Gauss-Seidel iterative method

UNIT II**9 Hours****INTERPOLATION**

Interpolation: Newton forward/backward interpolation- Lagranges - Newtons divided difference Interpolation.

UNIT III**9 Hours****NUMERICAL DIFFERENTIATION**

Numerical single and double integration: Trapezoidal rule- Simpsons 1/3 rule - Expression for corresponding error terms.

UNIT IV

9 Hours

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION

Numerical solution of ordinary differential equation: Eulers method - Runge-Kutta methods- Milnes Predictor-Corrector methods- Adams Predictor-Corrector methods - Finite Difference method.

UNIT V

9 Hours

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION

Finite difference solution of parabolic equations by Crank-Nicholson method-elliptic equations by iterative methods-hyperbolic equations by explicit finite difference method.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, Eastern Economy Edition, 2009.
2. Grewal B. S, Numerical Methods in Engineering and Science with Programms in C & C++, Ninth Edition, Khanna Publications, 2010.
3. Gerald C.F and Wheatley P.O, Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2006.
4. Jain M.K, Iyengar S.R.K and Jain R.K Numerical Methods for Scientific and Engineering Computation New Age International (P) Ltd , New Delhi, 2005.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, Fifth Edition, PHI Learning Pvt. Ltd, 2012.
6. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, Cengage Learning, Ninth Edition, 2005.

18ME402 APPLIED HYDRAULICS AND PNEUMATICS**2023****Course Objectives**

- To learn about fluid power systems and its fundamentals.
- To impart knowledge on various types of hydraulic pumps and actuators.
- To learn about various fluid power control components and its functions.
- To study about various types of pneumatic components and servo system.
- To learn fluid power circuit design methods and its 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the fluid power system and its fundamentals.
2. Identify suitable hydraulic pumps and actuators for different applications.
3. Choose the suitable fluid power control components for various applications.
4. Choose the suitable pneumatic components for different applications.
5. Design fluid power circuit for given 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	3		2									1		2	
3	2	2	3									1		2	
4	3		1									1		2	
5	1	2	3		2							2		2	

UNIT I**4 Hours****FLUID POWER SYSTEMS AND FUNDAMENTALS**

Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Properties of hydraulic fluids-Fluid power symbols. Basics of Hydraulics-Applications of Pascals Law- Laminar and Turbulent flow- Reynolds number.

UNIT II

6 Hours

HYDRAULIC SYSTEM AND COMPONENTS

Sources of Hydraulic Power: Pumping theory - Pump classification - Gear pump, Vane Pump, piston pump, construction and working of pumps - pump performance . Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders - Single acting, Double acting, special cylinders like tandem, Rodless, Telescopic, Cushioning mechanism, Rotary actuators- Gear, Vane and Piston motors

UNIT III

7 Hours

CONTROL COMPONENTS

Construction and function of Control Components : Direction control valve - 3/2 , 4/2 , Shuttle and check valve. Pressure control valve: pressure reducing valve-pilot operated, relief valve - pilot operated and sequence valve. Flow control valve: pressure compensated and non-pressure compensated valves. Accumulators and Intensifiers: Types -weight and spring loaded - Accumulator circuits. Intensifier - Intensifier circuit.

UNIT IV

6 Hours

PNEUMATIC SYSTEM COMPONENTS AND SERVO SYSTEMS

Pneumatic Components: Compressors- Piston compressor working, Filter, Regulator and Lubricator Unit. Air control valves: Quick exhaust valve and Muffler. Pneumatic actuators-types. Servo systems : Hydro Mechanical servo systems, Electro hydraulic servo systems. Fluidics-Introduction.

UNIT V

7 Hours

DESIGN OF HYDRAULIC AND PNEUMATIC CIRCUITS

Introduction to PLC - ladder diagrams, PLC applications in fluid power control. Fluid Power Circuit Design, Speed control circuits, synchronizing circuit, Pneumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

1

2 Hours

EXPERIMENT 1

Identification of fluid power system components with its symbols.

2

2 Hours

EXPERIMENT 2

A study on pascals law with one application

3

3 Hours

EXPERIMENT 3

Simulation of single and double acting cylinder.

4

3 Hours

EXPERIMENT 4

Simulation of rotary actuator.

5

3 Hours

EXPERIMENT 5

Construction and simulation of basic hydraulic circuit using various control components.

6

3 Hours

EXPERIMENT 6

Construction and simulation of hydraulic circuit using intensifier and accumulator.

7 **3 Hours**

EXPERIMENT 7

Construction and simulation of basic pneumatic circuit, with and without quick exhaust valve.

8 **3 Hours**

EXPERIMENT 8

Construction and simulation of pneumatic circuit, with and without muffler.

9 **4 Hours**

EXPERIMENT 9

Simulation of speed control circuits and sequential circuit.

10 **4 Hours**

EXPERIMENT 10

Design a simple circuit using cascade method and verify theoretically.

Total: 60 Hours

Reference(s)

1. Anthony Esposito, Fluid Power with Applications, Pearson Education New Delhi, 2011
2. S. R. Majumdar, Oil Hydraulics, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2004.
3. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2003.
4. S. R. Majumdar, Pneumatic systems Principles and maintenance, Tata McGraw Hill Publishing Company Pvt Ltd. New Delhi, 2008
5. S. Illango, V. Soundarrajan, Introduction to Hydraulics and Pneumatics, Prentice hall of India, New Delhi, 2007.
6. <https://www.youtube.com/watch?v=8xd7cWvMrvE>

18ME403 DYNAMICS OF MACHINES**2 1 2 4****Course Objectives**

- To impart knowledge in dynamic analysis of simple mechanism and design of flywheel.
- To provide knowledge on balancing of rotating and reciprocating masses.
- To study the working principle of governor and gyroscope.
- To learn the concept of free and forced vibration.
- To learn the concept of transverse and torsional vibration.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Perform dynamic analysis of simple mechanism and design of flywheel.
2. Estimate the balancing mass for rotating and reciprocating masses by using the force and couple polygon.
3. Compute the range of speed for governor and gyroscopic effect of ship and aero plane
4. Evaluate the natural frequency of single degrees of freedom system subjected to free and forced vibration.
5. Calculate the natural frequency of transverse and torsional vibration of single, two and three rotors system.

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										1	2		
3	3	2											2		
4	2	2										1	2		
5	1	2										1	2		

UNIT I**6 Hours****DYNAMIC FORCE ANALYSIS OF MECHANISMS**

Principle of superposition, Condition for dynamic analysis, Dynamic analysis of four bar & slider crank mechanism - Engine force analysis. Turning moment diagram for steam & IC Engine. Energy stored in flywheel, Dimension of flywheel rim, Flywheel in punching press.

UNIT II**6 Hours****BALANCING**

Introduction - Static balancing and dynamic balancing, Balancing of Rotating mass-several masses in same and different plane-Balancing of reciprocating mass-Swaying couple, Tractive force, Hammer Blow. Balancing of coupled locomotives.

UNIT III

6 Hours

GOVERNOR AND GYROSCOPE

Governor Terminology, Working principle, Types - Watt, Porter and Proell governor, Characteristics of Governor-sensitiveness, Hunting, Ichoronism, Stability. Gyroscope- Gyroscopic effect, gyroscopic couple, gyroscopic effect on aero planes and naval ships.

UNIT IV

6 Hours

FUNDAMENTALS OF VIBRATION

Introduction-Terminology, Classification, elements of vibration, free undamped vibration, Free Damped vibration (Viscus Damping) - Damping ratio and logarithmic decrement. Forced damped vibration - Magnification factor. Vibration isolation and transmissibility.

UNIT V

6 Hours

TRANSVERSE AND TORSIONAL VIBRATION

Transverse vibration of shafts and beams, Shaft carrying several loads, whirling of shafts. Torsional vibration- effect of inertia on torsional vibration-Torsionally equivalent Shaft, single rotor, two rotor and three rotor system.

1

3 Hours

EXPERIMENT 1

Determine the moment of inertia of object by flywheel.

2

3 Hours

EXPERIMENT 2

Dynamic analysis of four bar mechanism using CAD software

3

3 Hours

EXPERIMENT 3

Exercise on Balancing of reciprocating masses in slider crank mechanism.

4

3 Hours

EXPERIMENT 4

Exercise on Balancing of four rotating masses placed on different plane.

5

3 Hours

EXPERIMENT 5

Determine the characteristics and effort of Porter and Proell Governors.

6

3 Hours

EXPERIMENT 6

Analyze the gyroscopic effect using Gyroscope and verify its laws.

7

3 Hours

EXPERIMENT 7

Determination of natural frequency of single degree of freedom system.

8

3 Hours

EXPERIMENT 8

Determine the frequency of forced vibration using electro dynamic shaker.

9

3 Hours

EXPERIMENT 9

Determination of critical speed of shaft with concentrated loads (Whirling of shaft)

10

3 Hours

EXPERIMENT 10

Determine the natural frequency of cantilever beam.

Tutorial: 15 Hours

Total: 75 Hours

Reference(s)

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2014.
2. John J Uicker and Joseph E. Shigley, Theory of Machines and Mechanism, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2005.
3. Ashok G Ambekar, Mechanism and Machine Theory, Prentice Hall of India, New Delhi, 2009.
4. R. L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2005.
5. Sadhu Singh, Theory of Machines, Prentice Hall of India, New Delhi, 2007.
6. <https://nptel.ac.in/courses/112104114/9>

18ME404 STRENGTH OF MATERIALS**2 1 2 4****Course Objectives**

- To provide knowledge about stress distribution and strains in regular and composite structures subjected to axial loads
- To familiarize about two dimensional stress systems and stresses in thin cylinders
- To give input on shear force, bending moment diagrams and evaluate the bending stress in different beams under transverse loading
- To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions
- To provide awareness on 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Find the stress distribution and strains in regular and composite structures subjected to axial loads.
2. Evaluate the compound stresses in two dimensional systems and thin cylinders
3. Assess the shear force, bending moment and bending stresses in beams under transverse loading
4. Evaluate the 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	3	1	1									1	1		
2	3	2	2									2	2		
3	3	2	2									2	2		
4	3	2	2									2	2		
5	3	1	2									2	2		

UNIT I**6 Hours****STRESS, STRAIN AND DEFORMATION OF SOLIDS**

Introduction to material properties, Stress-strain curve for ductile and brittle materials, Hooke's law, Stresses and strains due to axial force in Stepped and Composite bars, Stresses due to thermal effect in composite bars, Factor of safety, Poisson-ratio, Elastic constants and their relationship

UNIT II STRESSES IN TWO DIMENSIONS State of stresses at a point, Normal and shear stresses on inclined planes, Principal planes and Principal stresses, Plane of maximum shear stress, Mohr's circle for bi-axial stress with shear stress. Hoop and longitudinal stresses in thin cylindrical vessels, Maximum Shear stress, Changes in dimensions and volume	6 Hours
UNIT III SHEAR FORCE, BENDING MOMENT AND STRESSES IN 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, Bending stress and stress variation along the length and section of the beam, Section modulus.	6 Hours
UNIT IV DEFLECTION OF BEAMS AND COLUMNS Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay's method. Types of Columns, Equivalent length, Euler and Rankine's formulae, Slenderness ratio	6 Hours
UNIT V TORSION IN SHAFT AND HELICAL SPRING Torsion of circular solid and hollow shafts, shear strength, angle of twist and torsional stiffness. Closed coil helical spring-stresses and deflection under axial load, Maximum shear stress in spring section including Wahl's Factor	6 Hours
1 EXPERIMENT 1 Find the hardness of the material using Rockwell hardness tester	3 Hours
2 EXPERIMENT 2 Calculate the hardness of the material using Brinell hardness tester	3 Hours
3 EXPERIMENT 3 Calculate the hardness of the material using micro Vickers hardness tester	3 Hours
4 EXPERIMENT 4 Plot stress-strain curve by observing the tensile behaviour of the given specimen	3 Hours
5 EXPERIMENT 5 Study the deflection of a simply supported beam and compare the experimental values of deflection with the theoretical values.	3 Hours
6 EXPERIMENT 6 Determine the compressive strength of the materials	3 Hours

7 **3 Hours**

EXPERIMENT 7

Calculate the strains in cylindrical vessels subjected to internal pressure through thin cylinder test setup

8 **3 Hours**

EXPERIMENT 8

Experimentally determine the strain energy of a material subjected to impact loading

9 **3 Hours**

EXPERIMENT 9

Determination of spring constant through load vs deflection curve

10 **3 Hours**

EXPERIMENT 10

Experimental analysis of a bar under torsion to obtain stiffness and angle of twist

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

18ME405 THERMAL ENGINEERING**2 1 2 4****Course Objectives**

- To study the components, systems and performance of internal combustion engines
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of Brayton cycle and steam power cycles
- To provide knowledge on steam nozzles and steam turbines
- To impart knowledge on working principles and performance of air compressors
- 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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Recognize the components and compute the performance of internal combustion engines
2. Illustrate the working of Brayton and steam power cycles in T-S diagram and formulate its efficiency
3. Resolve the problems involving steam nozzles and steam turbines
4. Compare the working and performance of reciprocating and rotary compressors
5. Estimate the capacity of refrigeration and air conditioning system

Articulation Matrix

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

UNIT I**6 Hours****INTERNAL COMBUSTION ENGINES**

Internal combustion engines - classification, components and functions - Fuel supply systems - Ignition Systems - Lubrication system and cooling system - Performance calculation - Heat balance sheet.

UNIT II	6 Hours
POWER PLANT CYCLES	
Gas turbine power plant cycle - Brayton cycle, expression for efficiency, work ratio. Modifications of Brayton cycle with intercooler, reheater and regenerator. Steam power plant cycle - Rankine cycle, modifications with reheater and regenerator.	
UNIT III	6 Hours
STEAM NOZZLES AND TURBINES	
Flow of steam through nozzles - shapes of nozzles, effect of friction, critical pressure ratio. Impulse and reaction turbines - compounding of turbines - velocity diagrams for simple and multistage turbines.	
UNIT IV	6 Hours
AIR COMPRESSORS	
Classification and working principle - work of compression with and without clearance, volumetric efficiency, isothermal efficiency and isentropic efficiency of reciprocating air compressors. Multistage air compressor, Work of compression. Rotary compressors - Centrifugal, vane and roots blower, screw compressors.	
UNIT V	6 Hours
REFRIGERATION AND AIR-CONDITIONING	
Vapour compression refrigeration cycle - Effect of operating conditions on COP, performance calculations. Working principle of vapour absorption system- Ammonia-water, Lithium bromide-water systems (Elementary treatment only), comparison between vapour compression and absorption systems. Cooling load calculations, Concept of RSHP, GSHP, ESHF, Air conditioning systems.	
FOR FURTHER READING	
Introduction to Super charger and turbo charger - Twin charging, Two-speed and two-stage superchargers. Emissions in an IC engine - Exhaust gas analysis, pollution control norms.	
1	3 Hours
EXPERIMENT 1	
Experimental study on port timing and valve timing diagram of IC engines.	
2	3 Hours
EXPERIMENT 2	
Experimental study on performance test of 4-Stroke diesel engine	
3	3 Hours
EXPERIMENT 3	
Experimental study on heat balance test of 4-Stroke diesel engine	
4	3 Hours
EXPERIMENT 4	
Experimental study on performance test of 4-Stroke Petrol engine	
5	3 Hours
EXPERIMENT 5	
Morse test on multi-cylinder petrol engine	
6	3 Hours
EXPERIMENT 6	

Study of steam turbines and steam nozzles

7 **3 Hours**

EXPERIMENT 7

Experimental study on performance of two stage reciprocating air compressor

8 **3 Hours**

EXPERIMENT 8

Experimental study on rotary compressors

9 **3 Hours**

EXPERIMENT 9

Experimental study on determination of Coefficient of Performance of refrigeration system

10 **3 Hours**

EXPERIMENT 10

Experimental study on determination of Coefficient of Performance of Air-conditioning system

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

**18ME406 MICROPROCESSORS AND
MICROCONTROLLER****2023****Course Objectives**

- To acquire basic knowledge about Microprocessors and Microcontrollers.
- To study the architectures of microprocessor
- To study the architectures of microcontroller.
- To impart the programming skills on 8085 and 8051 microprocessors.
- To understand the Programming analyzing concept of various peripheral interfacing with 8085.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify the various types of microprocessors and microcontrollers.
2. Explain the fundamental concepts of the microprocessor.
3. Explain and use the basic concepts of the microcontroller.
4. Develop the logical programmes using 8085 and 8051 microprocessors.
5. Analyse the various peripheral interfacing with 8085.

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	2	1		2								1		
4	2	2	2		2								1		
5	2	2	3		2								1		

UNIT I**6 Hours****8085 CPU**

Functional Building Blocks of Processor - 8085 Pin Diagram - 8085 Architecture - Instruction set - Addressing modes - Timing diagrams - Assembly language programming - Stack - Interrupts.

UNIT II**6 Hours****8085 INTERFACING**

Memory interfacing - Interfacing, I/O devices - Interfacing Serial I/O (8251) - Parallel I/O (8255) - Keyboard / Display controller (8279).

UNIT III	6 Hours
PERIPHERALS INTERFACING ADC/DAC interfacing - Inter Integrated Circuits interfacing (I2C Standard) - Case studies: Traffic Light control, LED display interface using 8085 microprocessor.	
UNIT IV	6 Hours
8051 MICROCONTROLLER Functional Building Blocks of 8051 Micro-controller - 8051 Micro-controller Hardware - I/O Pins, Ports and Circuits - Timing Diagram - External Memory - Interrupts.	
UNIT V	6 Hours
8051 PROGRAMMING AND APPLICATIONS Special Function Registers(SFRs) - 8051 Instruction Set - Addressing Modes - Assembly Language Programming - I/O Port Programming - Case studies : Interfacing - Sensors, Stepper Motors using 8051 Micro-Controller.	
1	4 Hours
EXPERIMENT 1 Programs for 8/16 bit Arithmetic operations (Addition / Subtraction) (Using 8085).	
2	2 Hours
EXPERIMENT 2 Programs for 8 bit Arithmetic operations (Multiplication / Division) (Using 8085).	
3	4 Hours
EXPERIMENT 3 Program for finding Ascending order and Descending order (Using 8085).	
4	4 Hours
EXPERIMENT 4 Program for finding Maximum and Minimum number (Using 8085).	
5	4 Hours
EXPERIMENT 5 Interfacing and Programming of 8279	
6	2 Hours
EXPERIMENT 6 Interfacing and Programming of 8255	
7	2 Hours
EXPERIMENT 7 Interfacing of Analog to Digital Converter (ADC) using 8085 microprocessor.	
8	2 Hours
EXPERIMENT 8 Interfacing of Digital to Analog Converter (DAC) using 8085 microprocessor.	
9	2 Hours
EXPERIMENT 9 Programming Arithmetic operation (Addition / Subtraction) using 8051 microcontroller.	

10

4 Hours

EXPERIMENT 10

Programming Arithmetic operation (Multiplication / Division) using 8051 microcontroller.

Total: 60 Hours

Reference(s)

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and application with 8085, Penram International Publishing, New Delhi, 2012.
2. John Uffenbeck, The 80x86 Family, Design, Programming and Interfacing, Pearson Education, New Delhi, 2012.
3. Mohammed Ali Mazidi and Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education Asia, New Delhi, 2013.
4. A. K. Ray and K. M. Burchandi, Intel Microprocessors Architecture Programming and Interfacing, McGraw Hill International Edition, New Delhi, 2000.
5. M. Rafi Quazzaman, Microprocessors Theory and Applications, Intel and Motorola, Prentice Hall of India, New Delhi, 2003.
6. https://onlinecourses.nptel.ac.in/noc19_ee11/preview

18ME407 COMPUTER AIDED MODELLING LABORATORY II

0 0 4 2

Course Objectives

- To provide skills to create drafting from part and assembly models.
- To impart the skill to create surface models of automotive/ machine components
- To provide knowledge on generating models of sheet metal components .
- To provide knowledge to create simulation of assembly models/mechanisms
- To expose the knowledge to prepare the technical documents of complete assembly using Product Lifecycle Management (PLM) concepts

Programme Outcomes (POs)

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Create orthographic projections of components/assembly from part/assembly models
2. Construct three dimensional surface models of automotive/ machine components.
3. Construct the three dimensional sheet metal models of automotive /machine elements
4. Create the simulation of mechanisms and analyze its collisions
5. Prepare the technical documents for the given component/assembly using PLM concepts

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	1			2		
4					3				2	1			2		
5					3				2	1			2		

1

6 Hours

EXPERIMENT 1

Create a detailed orthographic view of machine components from part/ assembly models with tolerances

2

6 Hours

EXPERIMENT 2

Create the detailed 2D orthographic sectional views from 3D part/assembly models with geometrical features

3	6 Hours
EXPERIMENT 3	
Generate a three dimensional surface models of automotive components	
4	6 Hours
EXPERIMENT 4	
Create a three dimensional surface models of pet bottles for specific capacities.	
5	6 Hours
EXPERIMENT 5	
Build sheet metal models of automotive components.	
6	6 Hours
EXPERIMENT 6	
Build sheet metal models of Air Conditioning Systems.	
7	6 Hours
EXPERIMENT 7	
Create simulation of slider crank mechanisms and analyze its collisions.	
8	6 Hours
EXPERIMENT 8	
Create simulation of hydraulic /pneumatic systems analyze its collisions	
9	6 Hours
EXPERIMENT 9	
Create a three dimensional assembly model and generate the detailed document with PLM concept.	
10	6 Hours
EXPERIMENT 10	
Prepare technical documents for an I.C. Engine Assembly with PLM concepts.	

Total: 60 Hours

Reference(s)

1. Creo Parametric 2.0 for Engineers and Designers, Prof Sham Tickoo, Prabhakar Singh.
2. Geometric Modelling: Theoretical and Computational Basis towards Advanced CAD Applications, Fumihiko Kimura
3. Theory of Modeling and Simulation, Bernard P. Zeigler, Herbert Praehofer, Tag Gon Kim, 2000
4. Product Lifecycle Management: 21st Century Paradigm for Product Realisation, John Stark, Springer, 2005

18HS001 ENVIRONMENTAL SCIENCE**2 0 0 0****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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Identify the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts 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											1		
2	1	1											1		
3	2	2					1						1		
4	1												1		
5	2												1		

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) - water logging - salinity - case studies. Energy resources: renewable(solar, wind, tidal, geothermal and hydroelectric power) - non renewable energy sources

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: forest ecosystem - desert ecosystem - ecological succession. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of

biodiversity: In-situ and ex-situ conservation of biodiversity - field study

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) - marine pollution - thermal pollution - noise pollution. Disaster management: causes - effects - control measures of floods - earthquake - cyclone - landslides

UNIT IV

7 Hours

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - urban problems related to energy. Environmental ethics - issues and possible solutions - solid waste management - causes - effects - 3R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. Environment protection act: Air (Prevention and control of pollution) act - wildlife protection act.

UNIT V

5 Hours

HUMAN POPULATION AND ENVIRONMENT

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

FOR FURTHER READING

Human rights: E - waste and biomedical waste -Identification of adulterants in food materials

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edition, New Age International Publishers, New Delhi, 2014.
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R., Environment. 8th edition. John Wiley & Sons, 2012.
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., Environmental and Pollution Science, Academic Press, 2011.
5. A. K. De, Environmental Chemistry, 7th Edition, New age international publishers, New Delhi, 2014.

18GE401 SOFT SKILLS-BUSINESS ENGLISH**0 0 2 0****Course Objectives**

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

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.

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

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

UNIT I**15 Hours****LISTENING AND READING**

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts - identify paraphrases of required information Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II**15 Hours****WRITING AND SPEAKING**

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 30 Hourx**Reference(s)**

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice

21ME501 METROLOGY AND INSTRUMENTATION**2023****Course Objectives**

- To study the concepts of measurement and characteristics of instruments.
- To learn the method of linear and angular measurements.
- To provide knowledge on measurement of thread and gear terminologies using suitable instruments.
- To study the use of laser and advances in metrology for linear geometric dimensions.
- To provide knowledge on measurement of mechanical parameters using suitable instruments.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the basic concepts of measurement and characteristics of measuring instruments.
2. Practice the appropriate linear and angular measurements using precision measuring instruments.
3. Examine the major terminologies for screw thread, gear and roundness measurement.
4. Apply the advanced techniques in metrology to calculate the geometric dimensions.
5. Explain the methods used to measure the mechanical parameters.

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	
3	2	2							2	1		1		2	
4	2	2			2				2	1		1		2	
5	2	2							2	1		1		2	

UNIT I**4 Hours****BASICS OF METROLOGY**

Introduction - Types of measuring system - Standards of measurements - Line, End and wavelength. Calibration, Characteristics of measuring instruments. Errors in Measurement - Types, Methods of measurement - Care of Measuring Instruments.

UNIT II

6 Hours

LINEAR AND ANGULAR MEASUREMENTS

Linear Measuring Instruments: Vernier Caliper, Vernier Height and Vernier Depth Gauge, Inside, Outside and Depth Micrometer, Slip Gauge, Limit Gauge - Comparator: Mechanical, Pneumatic and Electrical - Angular Measurements: Bevel protractor, Sine bar, Angle Decker, Autocollimator.

UNIT III

7 Hours

FORM MEASUREMENTS

Thread Measurement: Terminologies, Errors - External Thread Measurement: Pitch Gauge, Tool Maker's microscope, Floating Carriage micrometer with One, Two and Three wires method - Internal Thread Measurements. Gear Measurement: Terminologies, Errors, Gear Tooth Vernier caliper, Profile Projector, Base pitch measuring instrument, David Brown Tangent Comparator, Parkinson Gear Tester - External and Internal Radius measurements - Roundness measurement: Circumferential confining gauge, Assessment using V block and Rotating centers. Straightness and Flatness Measurement.

UNIT IV

7 Hours

ADVANCES IN METROLOGY

Interferometer: NPL Flatness, Laser, Michelson - Coordinate Measuring Machine: Basic concept, Types, Constructional features, Probes, Accessories - Surface Roughness Measurement - Machine Tool Metrology.

UNIT V

6 Hours

MEASUREMENT OF MECHANICAL PARAMETERS

Measurement of Force - Principle, analytical balance, platform balance, proving ring. Torque - Prony brake, hydraulic dynamometer. Measurement of Power: Linear and Rotational - Pressure Measurement: Principle, use of elastic members, Bridgman gauge, McLeod gauge, Pirani gauge - Temperature Measurement: bimetallic strip, thermocouples, metal resistance thermometer, pyrometers.

1

3 Hours

EXPERIMENT 1

Comparing the accuracy of vernier caliper, vernier height gauge and micrometer to check the various dimensions of a given specimen.

2

3 Hours

EXPERIMENT 2

Checking the dimensional limits of ten similar components using mechanical comparator.

3

3 Hours

EXPERIMENT 3

Measurement of taper angle of a given specimen by direct and indirect method.

4

3 Hours

EXPERIMENT 4

Measurement of screw thread specifications by direct and indirect method.

5

3 Hours

EXPERIMENT 5

Measurement of gear tooth specifications by using Gear tooth vernier calliper / Tool maker microscope / Profile projector / Parkinson gear rolling tester.

6	3 Hours
EXPERIMENT 6 Differentiate the work piece by its surface roughness value.	
7	3 Hours
EXPERIMENT 7 Measurement of Straightness of a given job by using Autocollimator and Interferometer.	
8	3 Hours
EXPERIMENT 8 Machine tool alignment test on Lathe / Milling machine / Drilling machine.	
9	3 Hours
EXPERIMENT 9 Measurement of torque in a cantilever beam.	
10	3 Hours
EXPERIMENT 10 Temperature measurement by using Bimetallic strip / Thermocouples / Pyrometer.	
Total: 60 Hours	

Reference(s)

1. Bewoor, Vinay Kulkarni, Metrology & Measurement, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2009.
2. Alan S. Morris, The Essence of Measurement, Prentice Hall of India, New Delhi, 2001.
3. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009.
4. A. K. Jayal, Instrumentation and Mechanical Measurements, Galgotia Publications, New Delhi, 2000.
5. T. G. Beckwith, N. Lewis Buck, Mechanical Measurements, Addison Wesley, New Delhi, 2008.

21ME502 DESIGN OF MACHINE ELEMENTS**3 1 0 4****Course Objectives**

- To learn the design procedure of machine elements subjected to simple and variable loads.
- To study the design procedure of shafts and couplings.
- To provide knowledge on the design of bolted and welded joints
- To provide knowledge on the design of helical, leaf and torsional springs subjected to constant and variable loads.
- To study the selection procedure of sliding and rolling contact bearings.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Design machine elements subjected to simple and variable loads.
2. Design shaft and couplings for various engineering applications.
3. Design bolted and welded joints subjected to static load.
4. Design helical, leaf and torsional springs subjected to constant and variable loads
5. Select suitable bearings for axial and radial loading conditions from manufacturers catalogue.

Articulation Matrix

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

UNIT I**10 Hours****STEADY AND VARIABLE STRESSES**

Introduction to the design process - Design of straight and curved beams - C -frame and Crane hook. Stress concentration - Design for variable loading - Soderberg, Goodman, Gerber methods and combined stresses - Theories of failure.

UNIT II

10 Hours

DESIGN OF SHAFTS AND COUPLINGS

Design of shafts based on strength, rigidity and critical speed. Design of rigid flange coupling -Design of flexible coupling.

UNIT III

9 Hours

DESIGN OF JOINTS

Design of bolted joints - stresses due to static loading, eccentric loading. Design of welded joints - Butt and Fillet welded Joints - Strength of parallel and transverse fillet welded Joints - Eccentrically loaded joints.

UNIT IV

8 Hours

DESIGN OF SPRINGS

Types, End connections and design parameters. Design of helical springs - Circular and noncircular wire - Concentric springs. Design of leaf and torsional springs under constant and varying loads - Wahl's stress factor.

UNIT V

8 Hours

DESIGN OF BEARINGS

Types and selection criteria - Design of journal bearings - Design of rolling contact bearing - Ball and roller bearing.

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, 2010.
2. J. E. Shigley and C. R. Mischke, Mechanical Engineering Design, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2011
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.Kalai kathir Achchagam, 2013.

21ME503 COMPUTER AIDED MANUFACTURING I**2023****Course Objectives**

- To educate the concept, applications and emerging trends in CNC machines
- To impart the knowledge on construction and working of Computer Numerical Control (CNC) Machines, maintenance and retrofitting of CNC machines.
- To provide knowledge on interfacing, communication and control of CNC drives.
- To impart the knowledge on CNC programming basics
- To introduce programming of CNC turning center.

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the Various concepts and select the suitable CNC for the given application.
2. Explain the construction, working and maintenance of CNC machine tools
3. Assess the interfacing drives, feedback devices used in CNC machine tools using programmable logic control (PLC) and other peripherals
4. Understand the various concepts in CNC programming
5. Formulate the programs to manufacture components in CNC turning center for popular controller

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	
3	2	2			1				2	1		1		2	
4	2	2			1				2	1		1		2	
5	2	2			1				2	1		1		2	

UNIT I FUNDAMENTALS OF CNC MACHINES Introduction to Computer Numerical Control: Evolution of CNC Technology, CNC Systems - An Overview of Fundamental aspects of machine control, Different types of CNC machines - Advantages, disadvantages and applications of CNC machines- DNC and Adaptive control	6 Hours
UNIT II CONSTRUCTION OF CNC AND MOTION CONTROL Constructional features and applications - Linear motion and Recirculating ball bearings - CNC controller and Interpolator - Maintenance and retrofitting. Tool magazines, ATC, APC, Chip conveyors.	6 Hours
UNIT III DRIVES AND CONTROL Spindle and feed drives - Sensors -Position, Encoders, Proximity, Limit switch -Interfacing system - Microcontroller and PLC based -Introduction to Graphical User interface -Communication protocol - RS232, RS 485, USB, Ethernet -PLC -Ladder diagram -Peripherals -Timer, Counter, Encoder interface, Human Machine Interface.	6 Hours
UNIT IV BASICS OF CNC PROGRAMMING Cutting tool Inserts - Materials, Classification, Nomenclature and Selection - Tool holders and Work holding devices - Coordinate system - Structure of a part program - G & M Codes -Programming for FANUC and SIEMENS controller. tool offset, work offset, cutter radius compensation	6 Hours
UNIT V 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.	6 Hours
1 EXPERIMENT 1 Simulation and NC part program generation on facing and step turning	5 Hours
2 EXPERIMENT 2 Simulation and NC part program generation on taper turning and profile turning	5 Hours
3 EXPERIMENT 3 Simulation and NC part program generation on grooving cycle and thread cutting	5 Hours
4 EXPERIMENT 4 Simulation and NC part program generation on drilling and boring cycle	5 Hours
5 EXPERIMENT 5 To make one of the following product: Push fit assembly/simple cylinder piston assembly/milling tool holder/needle valve spool	10 Hours

Total: 60 Hours

Reference(s)

1. P. Radhakrishnan, S. Subramanyan and V. Raja , CAD/CAM/CIM, New Age International Private Ltd, NewDelhi, 2008
2. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, 2004.
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

21ME504 HEAT AND MASS TRANSFER**3 1 2 5****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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. To recall the partial differential equations and electrical analogy and solve the problems in conduction heat transfer
2. To identify the correlation to find the heat transfer rate in free and forced convection
3. To use shape factor algebra and electrical analogy to find the heat transfer rate in radiation
4. To integrate the concepts of phase change heat transfer & compare the thermal performance of heat exchangers using LMTD or NTU approach
5. To find the mass transfer rate in diffusion and convective mass transfer applications

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								3
2	2	3	2	2	1		2								3
3	3	3	2	2			2								3
4	2	3	2	2			2								3
5	2	3	2	2			2								3

UNIT I	10 Hours
CONDUCTION	
Basic concepts - mechanism of heat transfer. Conduction - Fourier's law, general differential equation in cartesian and cylindrical coordinates, one dimensional steady state heat conduction, conduction through plane wall, cylinders and spherical systems. Composite Systems. Extended surfaces.	
UNIT II	9 Hours
CONVECTION	
Basic concepts - Heat transfer coefficients, boundary layer concept. Forced convection - non-dimensional numbers, external flow- flow over plates, cylinders and spheres, internal flow- laminar and turbulent flow. Free convection- non-dimensional numbers, flow over vertical plate, horizontal plate.	
UNIT III	8 Hours
RADIATION	
Laws of radiation- Stefan-Boltzmann law, Kirchhoff's law - Black body radiation - Grey body radiation - Shape factor algebra - Electrical analogy - Radiation shields.	
UNIT IV	10 Hours
PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS	
Boiling: Modes- correlations used. Condensation: Nusselt theory, types, correlations used. Heat exchangers : Types, heat exchanger analysis, fouling factor, LMTD (Logarithmic mean temperature difference) and Effectiveness - NTU (number of transfer units) Method - Overall heat transfer coefficient.	
UNIT V	8 Hours
MASS TRANSFER	
Basic concepts - Diffusion mass transfer - Fick's law of diffusion, Steady state molecular diffusion. Convective mass transfer- correlations. Momentum, heat and mass transfer analogy.	
FOR FURTHER READING	
Two dimensional steady state heat conduction. Use of Heisler Chart, Unsteady state conduction. Numerical methods in heat conduction.	
1	3 Hours
EXPERIMENT 1	
Determination of thermal conductivity for one dimensional steady state conduction	
2	3 Hours
EXPERIMENT 2	
Determination of heat transfer co-efficient by unsteady heat transfer	
3	3 Hours
EXPERIMENT 3	
Determination of heat transfer co-efficient by natural convection	
4	3 Hours
EXPERIMENT 4	
Determination of heat transfer co-efficient by forced convection	
5	3 Hours
EXPERIMENT 5	
Determination of Stefan-Boltzmann constant	

6 **3 Hours**

EXPERIMENT 6

Determination of emissivity using emissivity apparatus

7 **3 Hours**

EXPERIMENT 7

Determination of overall heat transfer for film wise and drop wise condensation

8 **3 Hours**

EXPERIMENT 8

Determination of overall heat transfer co-efficient for a parallel and counterflow heat exchanger

9 **3 Hours**

EXPERIMENT 9

Experimentation on mass transfer

10 **3 Hours**

EXPERIMENT 10

Determination of overall heat transfer co-efficient for a fluidized bed heat transfer

Tutorial: 15 Hours

Total: 90 Hours

Reference(s)

1. Yunus A. Cengel, Heat and Mass Transfer: a Practical Approach, Tata McGraw Hill publishing Company private limited, New Delhi, 2017
2. J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, New Delhi, 2008
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, 2007
6. <https://nptel.ac.in/courses/112101097/>

21GE501 SOFT SKILLS - APTITUDE I**0 0 2 0****Course Objectives**

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

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.

Course Outcomes (COs)

- Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
- Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
- Apply different techniques to find the distance, speed and time of various moving objects.
- Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

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					
4									2	2					

1**4 Hours****NUMBER SYSTEMS**

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2**2 Hours****PERCENTAGE**

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

3**2 Hours****AVERAGES AND AGES**

Introduction-Average of different groups-Addition or removal of items and change in average- Replacement of some of the items.

4

2 Hours

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios- Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5

4 Hours

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6

2 Hours

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7

2 Hours

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8

2 Hours

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9

2 Hours

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10

2 Hours

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11

2 Hours

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12

2 Hours

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21HS002 HUMAN VALUES AND ETHICS**2 0 0 2****Course Objectives**

- To understand Human Values and ethical theory.
- To understand codes of ethics, work place responsibilities, rights, engineering experimentation, global issues and contemporary ethical issues.
- To understand personal ethics, legal ethics, cultural ethics and engineers responsibility.

Programme Outcomes (POs)

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.

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.

Course Outcomes (COs)

1. Articulate engineering ethics theory with sustained lifelong learning.
2. Adopt a good character and follow high professional ethical life.
3. Contribute to shape a better character by following ethical actions.
4. Confront and resolve moral issues occurred during technological activities.
5. Resolve moral and ethical problems through exploration and assessment by established experiments.

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				
4								2	2		2				
5								2	1		3				

UNIT I**6 Hours****HUMAN VALUES**

Morals and Ethics - Honesty - Integrity - Values - Work Ethic - Civic Virtue - Respect for Others – Living Peacefully - Caring and Sharing - Self-Confidence - Courage - Co-operation - Commitment - Empathy

UNIT II**6 Hours****ENGINEERING ETHICS AND PROFESSIONALISM**

Scope of Engineering Ethics- Variety of moral issues - Types of inquiry - Accepting and sharing responsibility - Ethical dilemmas - Moral autonomy - Kohlbergs and Gilligan's theory - Consensus and controversy - Profession and Professionalism - Models of Professional Roles - Right action theories - Senses of corporate responsibility - Codes of ethics: Importance - justification - limitation - Abuse.

UNIT III

6 Hours

ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as experimentation - Engineers as responsible experimenters - Balanced outlook on law - Cautious optimism - Safety and risk - Assessing and reducing risk - Safe exits - The Challenger case study - Bhopal Gas Tragedy - The Three Mile Island and Chernobyl

UNIT IV

6 Hours

WORKPLACE RESPONSIBILITIES AND RIGHTS

Fundamental Rights - Responsibilities and Duties of Indian Citizens - Teamwork - Ethical corporate Climate - Collegiality and loyalty - Managing conflict - Respect for authority - Collective bargaining - Confidentiality - Conflicts of interest - Occupational crime - Professional rights - Employee rights.

UNIT V

6 Hours

GLOBAL ISSUES

Multinational corporations: Technology transfer and appropriate technology - International rights - promoting morally just measures - Environmental ethics: Engineering, ecology - economics - Human and sentient centred - and bio and eco centric ethics - Computer ethics and internet - Engineers as managers - Consulting engineers - Engineers as expert witnesses and advisors - Moral leadership.

FOR FURTHER READING

Sample code of ethics like IETE, ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management.

Total: 30 Hours

Reference(s)

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering, 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014.
2. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi, 2012.
3. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited, New Delhi, 2006.
4. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey, 2004.
5. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics - Concepts and Cases, Wadsworth Thompson Learning, United States, 2005.
6. [http://www.slideworld.org/slidestag.aspx/human-values-and- Professional-ethics](http://www.slideworld.org/slidestag.aspx/human-values-and-Professional-ethics)

21ME602 MECHATRONICS**2023****Course Objectives**

- To introduce the concept and working of sensors used in mechatronic system.
- To study the interface of actuators with mechatronic system.
- To provide knowledge on feedback mechanism for improving the reliability of mechatronic system.
- To impart knowledge on working and programming of microcontroller in mechatronic systems
- To learn the Programmable Logic Controller (PLC) used in mechatronic 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Interface the different types of sensor with mechatronics system
2. Control position and speed of actuators used in mechatronics system.
3. Design a feedback controller for mechatronics system.
4. Programming the microcontroller to control actuators and sensor.
5. Programming PLC to develop a mechatronic system.

Articulation Matrix

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

UNIT I**6 Hours****SENSOR**

Components of mechatronics system, Sensor-terminology - Potentiometer, Linear Variable differential transformer, strain gauge, Piezoelectric sensor, Optical encoder, Hall effect sensor, thermistor.

UNIT II**6 Hours****ACTUATOR**

Mechanical Actuation system - cam, gear, belt & chain, Ball screw, Pneumatic & hydraulic Actuation system. Electrical actuation system - relay & solenoid, working & control of Stepper & servo motor.

UNIT III	6 Hours
FEEDBACK CONTROL Open loop system, closed loop system, Transfer Function, Mathematical Modeling of Mechanical & Electrical system, First order system, second order system, Proportional control, derivative control, Integral control, PID control.	
UNIT IV	6 Hours
MICROCONTROLLER Architecture of 8051- I/O Pins, Ports and Circuits, memory, counter, Timer, Interrupt, Instruction set- Moving data, Logical ,arithmetic operation, Jump & call instruction, Examples -Windscreen wiper motion, Car engine management.	
UNIT V	6 Hours
PROGRAMMABLE LOGIC CONTROLLER Basic Structure - Input / Output Processing - Programming - Mnemonics - Timers, Internal relays and counters - Shift Registers - Master and Jump Controls. Examples -Pick and place robot. Car park barrier system.	
1	3 Hours
EXPERIMENT 1 Interfacing ultrasonic sensor with microcontroller to measure non-contact displacement	
2	3 Hours
EXPERIMENT 2 Interfacing Encoder with microcontroller to measure position of DC motor.	
3	3 Hours
EXPERIMENT 3 Programming microcontroller to control the position of servo motor.	
4	3 Hours
EXPERIMENT 4 Design and simulation of pneumatic circuit using fluidsims software.	
5	3 Hours
EXPERIMENT 5 Design and simulation of PID controller for mechatronics system in MATLAB.	
6	3 Hours
EXPERIMENT 6 Design and development of temperature control system using microcontroller	
7	3 Hours
EXPERIMENT 7 Programming microcontroller for speed control of stepper motor.	
8	3 Hours
EXPERIMENT 8 Programming microcontroller for speed control of DC motor.	

9

3 Hours

EXPERIMENT 9

Design and simulation of double acting cylinder circuit using PLC

10

3 Hours

EXPERIMENT 10

Design and simulation of meter-in and meter-out circuit in Fluidsim.

Total: 60 Hours

Reference(s)

1. W. Bolton, Mechatronics, Pearson Education, New Delhi, 2012.
2. Godfrey Onwubolu, Mechatronics: Principles and Applications Butterworth-Heinemann Ltd, 2005.
3. Nitaigour Premchand Mahalik, Mechatronics : Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Pvt.
4. Krishna Kant, Microprocessors & Microcontrollers, Prentice Hall of India, 2007.
5. K. P. Ramachandran, G. K. Vijayaraghavan, and M. S. Bala-Sundram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi 2008.
6. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-roorkee/industrialengineering/index.htm>

21ME603 FINITE ELEMENT ANALYSIS**3 1 0 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 isoparametric 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply the numerical methods to formulate the simple finite element problems.
2. Apply one dimensional finite element method to solve bar, beam and truss type problems.
3. Apply finite element method for plane stress, plane strain and axisymmetric conditions.
4. Determine temperature distribution of one and two dimensional heat transfer problems using one and two dimensional finite elements.
5. Apply the numerical methods to formulate the higher order and isoparametric problems.

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**10 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**10 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

8 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

9 Hours

HEAT TRANSFER APPLICATIONS

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

UNIT V

8 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 Isoparametric rectangular element using the natural coordinate system - problems. Gaussian quadrature method-problems.

FOR FURTHER READING

Construct the FEA steps for the structural and thermal analysis of machine elements

Tutorial: 15 Hours

Total: 60 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

21ME604 COMPUTER AIDED MANUFACTURING II**2023****Course Objectives**

- To study the principle and applications of automated material handling and automated inspection
- To learn the concept of economics and testing of machine tools.
- To provide exhaustive skill on programming of CNC machining center.
- To learn the concept of NC code generation through CAD models.
- To educate the concept, applications macro and parametric programming.

Programme Outcomes (POs)

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

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Compare and select suitable automated material handling system and automated inspection methods for given applications.
2. Understand the economics factors and testing of CNC machines.
3. Formulate the programs to manufacture prismatic components using CNC machining centers for popular controller.
4. Understand the NC code generation through CAD models in CAM Software.
5. Apply the Macro and parametric programming for the given application.

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	
4	2													2	
5	2													2	

UNIT I**6 Hours****COMPUTER INTEGRATED MANUFACTURING**

Industrial Robot - robot anatomy, robot control systems, and other specifications, end effectors. Automated Guided Vehicle (AGV) Systems and Automated Storage and retrieval system (AS/RS) - basic components, types and its application. Automated inspection principles- Off line & on line inspection, distributed inspection & final inspection.

UNIT II**6 Hours****ECONOMICS AND TESTING OF MACHINE TOOLS**

Factors influencing selection of CNC Machines Cost of operation of CNC Machines Practical aspects of introducing CNC machines in industries. Geometrical alignment test, national and international test charts, testing of CNC machine tools

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**

PROGRAMMING USING CAM

CNC part programming using CAD/CAM software and interfacing with CNC machines - Component modeling, machine selection, tool selection, coordinate reference, step by step procedure, cutter location data, simulation, post processor.

UNIT V **6 Hours**

MACRO PROGRAMMING AND ADVANCED LEARNING

Introduction macro programming variables and its types, Introduction to parametric programming - Comparison to sub-programming, canned cycles and computer programming. Integration of addition axes features - programming, methodology.

1 **5 Hours**

EXPERIMENT 1

Simulation and NC part program generation on linear and circular interpolation

2 **5 Hours**

EXPERIMENT 2

Simulation and NC part program generation on contour milling

3 **5 Hours**

EXPERIMENT 3

Simulation and NC part program generation on drilling and peck drilling

4 **5 Hours**

EXPERIMENT 4

Simulation and NC part program generation on Mirror imaging in CNC Milling

5 **10 Hours**

EXPERIMENT 5

To make one of the following product: compression mould die/Injection mould die/simple mechanism/motor or turbine impeller assembly

Total: 60 Hours

Reference(s)

1. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
2. P. M. Agrawal and V. J. Patel, CNC Fundamentals and Programming, Charotar Publishing House Pvt. Ltd., 2014.
3. P. Radhakrishnan, Computer Numerical Control Machines, New Central Book Agency, 2004.

21ME608 COMPUTER AIDED ENGINEERING LABORATORY

0 0 4 2

Course Objectives

- To expose knowledge on the FEA software as a tool for the analysis of bars, trusses and beams.
- To model complex geometries and load conditions for the determination of stresses and strains.
- To perform plane stress, plane strain and axisymmetric simulations using FEA software.
- To apply the knowledge of torsion, buckling and dynamics to solve dynamic problems using FEA software.
- To obtain temperature distribution for heat conduction using FEA software.

Programme Outcomes (POs)

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

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Analysis of bars, trusses and beams using FEA software.
2. Analysis complex geometries and load conditions for the determination of stresses and strains.
3. Apply plane stress, plane strain and axisymmetric conditions using FEA software.
4. Torsional analysis of shafts, buckling of columns and dynamic analysis of simple structure using FEA software.
5. Thermal analysis of determining temperature distribution and thermal stresses using FEA software.

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		
4	2												2		
5	2													2	

1

4 Hours

EXPERIMENT 1

Structural analysis of a stepped bar to determine nodal displacements, stresses reaction forces.

2

4 Hours

EXPERIMENT 2

Analysis of simple and complex trusses to find displacements, stresses and reaction forces for the given loadings.

- | | |
|--|----------------|
| 3
EXPERIMENT 3
Analysis of cantilever beam, simply supported beam and fixed beam under different boundary and loading conditions. | 4 Hours |
| 4
EXPERIMENT 4
Analysis of corner angular plate with holes for the determination of Von mises stress and maximum deformation under static loading with one hole fixed and the other hole pressure loaded. | 4 Hours |
| 5
EXPERIMENT 5
Determination of Von mises stress and the maximum deformation that occur when a steel plate with holes is loaded as shown. The plate is constrained in y direction at bottom section and distributed load of 20 N pulling in the y-direction. The plate is made of steel with a Youngs modulus of 20×10^4 N/mm ² and the Poissons ratio of 0.3. | 4 Hours |
| 6
EXPERIMENT 6
Analysis of a compound bar under compression. | 4 Hours |
| 7
EXPERIMENT 7
Stress analysis of a thin plate with hole with uniform load along any one direction in plane stress. | 4 Hours |
| 8
EXPERIMENT 8
Analysis of a long cylindrical pressure vessel under plane strain. | 4 Hours |
| 9
EXPERIMENT 9
Analysis of a closed cylinder under pressure Axisymmetric | 4 Hours |
| 10
EXPERIMENT 10
Analysis of shaft subjected to twisting moments. | 4 Hours |
| 11
EXPERIMENT 11
To solve a simple buckling problem to determine the deflection and reaction forces. | 4 Hours |
| 12
EXPERIMENT 12
Modal analysis of Cantilever, Simply supported and Fixed beams under different boundary conditions | 4 Hours |
| 13
EXPERIMENT 13
Temperature distribution in circular and radial fins. | 4 Hours |

14

4 Hours

EXPERIMENT 14

Temperature distribution in 2D and 3 D components under different boundary conditions for a heat conduction analysis.

15

4 Hours

EXPERIMENT 15

Coupled temperature and stress analysis of a compound object to determine the thermal stresses.

Total: 60 Hours

Reference(s)

1. Stinivasan, K. C. Sambana adn RK Datti, Finite Element Analysis using Ansys 11.0, Paleti PHI Learning Pvt. Ltd, 2010.
2. Esam M. Alawadhi, Finite Element Simulations Using ANSYS, CRC Press, 2016.
3. Meung K, Finite Element Methods with Programming and Ansys, Lulu Com 2013
4. Saeed Moaveni, Finite Element Analysis Theory and Applications with Ansys, Pearson Education, 2014.

18GE601 SOFT SKILLS-APTITUDE II**0 0 2 0****Course Objectives**

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

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.

Course Outcomes (COs)

- Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
- Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
- Analyse objects involving cubes and cuboids in determining the number of sides colored.
- Interpret various data from graphs and tables to determine ratio, percentage and averages.
- Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

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					
4									2	2					
5									2	2					

1**2 Hours****PERMUTATION AND COMBINATION**

Definition-Fundamental rules-Theorems on Permutation-Theorems on Combination.

2**2 Hours****PROBABILITY**

Concept and Importance of Probability-Underlying factors for real Life estimation of probability-Basic facts about probability-Some important consideration while defining event.

3**2 Hours****SYLLOGISM AND VENN DIAGRAM**

Concepts on Syllogisms-Venn diagram-Interpretation-Venn diagram-solving.

4**4 Hours****SIMPLE INTEREST AND COMPOUND INTEREST**

Introduction-Definition - Effect of change of P, R, T on simple interest-Amount-Amount becomes N times the principle-Repayment of debt in equal installments-Rate and time are numerically equal-

Compound Interest-Conversion period-Basic formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual installment to pay the borrowed amount.

5

2 Hours

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6

4 Hours

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7

2 Hours

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8

2 Hours

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9

2 Hours

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10

2 Hours

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11

2 Hours

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12

2 Hours

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13

2 Hours

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21ME701 OPERATION RESEARCH**3 1 0 4****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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Formulate and select the suitable method to solve the linear programming problem.
2. Solve the different transportation and assignment based models.
3. Draw the network models and solve it.
4. Select the suitable queuing model and solve the given applications.
5. Find the total elapsed time and optimum replacement policy.

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										1		
3	1	2	1										1		
4		3			2								2		
5			2		1								1		

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

QUEUEING MODELS

Queueing 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.

FOR FURTHER READING

Application of queueing models in the banking sector, Formulate LPP for transporting goods from factory to customers. Software packages such as LINDO, LINGO, and TORA.

Tutorial: 15 Hours

Total: 60 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.

21ME702 INDUSTRIAL ROBOTICS**2023****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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Identify the components and construction of robot manipulator.
2. Select a suitable drive and an end effector for industrial robots.
3. Choose sensors and machine vision system for industrial robots.
4. Formulate forward & inverse kinematics and construct program for robots.
5. Discuss the usage and applications of robots in industries.

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											1	2		2
3	1												2		2
4	3	2										1	2		
5	1											2	2		2

UNIT I**6 Hours****FUNDAMENTAL OF ROBOTICS PROCESS**

Robot-Definition-Robotics and Automation - Law of robotics -Robot Anatomy -Co-ordinate Systems, Work Envelope, classification - Specifications - Pitch, Yaw, Roll, Joint Notations, Pay Load - Need for Robots

UNIT II**6 Hours****ROBOT DRIVE SYSTEM AND END EFFECTORS**

Pneumatic Drives, Hydraulic Drive, Mechanical Drives and Electrical Drives. End Effectors - Grippers -Pneumatic gripper, Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers, and Mechanical Grippers -Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers.

UNIT III

6 Hours

SENSORS AND MACHINE VISION SYSTEMS

Sensors - types - tactile sensors, proximity and range sensors, contact and non-contact sensors, velocity sensors, touch and slip sensors, force and torque sensors. Robotic vision systems, imaging components, image representation, picture coding, object recognition and categorization, visual inspection.

UNIT IV

6 Hours

ROBOT KINEMATICS AND PROGRAMMING

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) - Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages - VAL Programming - Motion Commands, Sensor Commands, End effector commands, and Simple programs.

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

1

3 Hours

EXPERIMENT 1

Study of various types of robots.

2

3 Hours

EXPERIMENT 2

Geometric Modeling: As an example of a geometric modeling system a SCARA robot is modeled in a common modeling language using an industrial robot simulation system

3

3 Hours

EXPERIMENT 3

Identification of various component in pneumatic and hydraulic drive system

4

3 Hours

EXPERIMENT 4

Automating the operation of a machine vice according to specified need using pilot valves.

5

3 Hours

EXPERIMENT 5

Load cell measurement

6

3 Hours

EXPERIMENT 6

Displacement measurement using LVDT

7

3 Hours

EXPERIMENT 7

Forward and Inverse Kinematics: The forward and inverse kinematics of the SCARA robot are derived and calculated in a simulation software.

8

3 Hours

EXPERIMENT 8

Offline Programming: The previously modelled SCARA robot is then programmed offline, also using the industrial robot simulation system.

9

3 Hours

EXPERIMENT 9

Programming a parallel kinematic robot for a pick and place application

10

3 Hours

EXPERIMENT 10

Programming the robot for a drilling application

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, 2012.
2. D. Richard, Klafter, A. Thomas, Chmielewski and Michael Negin, Robotics Engineering, An Integrated Approach, Prentice Hall of India, New Delhi, 2010.
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2003
4. Yoram Koren, Robotics for Engineers, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
5. James G. Keramas, Robot Technology Fundamentals, Cengage Learning, 2011.
6. <https://nptel.ac.in/courses/112103174/39>

21ME707 PROJECT WORK I

0063

Course Objectives

- To develop skills to formulate a technical project.
- To give guidance on the various tasks of the project and standard procedures.
- 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.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare technical report and oral presentations.

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	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

21ME801 PROJECT WORK II

00189

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.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare technical report and oral presentations.

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	2	1	3		2					2	2			
3			3	2	2			2			2	2			
4		1		2	3	1	2	2							
5									3	3		2			

21HS201 COMMUNICATIVE ENGLISH II**1022****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)

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. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

Articulation Matrix

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

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-Variety 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 FoundationBooks, 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.

21HSH01 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)

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.

Course Outcomes (COs)

1. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

Articulation Matrix

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

UNIT I**9 Hours****VOWELS AND CONSONANTS**

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarga -Table of Alphabet -Vocabulary.

UNIT 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.

21HSG01 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)

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.

Course Outcomes (COs)

1. Listen and identify individual sounds of German
2. use basic phonemes and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

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 -nationalities

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 & Distributors Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber München, 2007.

21HSJ01 JAPANESE**1022****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)

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.

Course Outcomes (COs)

1. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

Articulation Matrix

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

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.

21HSF01 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)

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.

Course Outcomes (COs)

1. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

Articulation Matrix

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

UNIT I**9 Hours****ENTRER EN CONTACT**

La langue française, alphabets, les numéros, les jours, les mois. Grammaire Les verbes s'appeler, être, avoir, les articles définis, indéfinis Communication Saluer, s'informer sur quelqu'un, demander de se présenter Lexique L'alphabet, les nationalités, l'âge, les pays, les couleurs, les jours de la semaine, les mois de l'année, les professions

UNIT II**9 Hours****PARTAGER SON LIEU DE VIE**

Les français et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Être / ER, IR, RE Régulier et Irrégulier) Adjectifs les propositions de lieu. Communication Chercher un logement, décrire son voisin, s'informer sur un logement - Lexique L'habitat, les pièces, l'équipement, la description physique

UNIT III**9 Hours****VIVRE AU QUOTIDIEN LES LOISIRS DES FRANÇAIS, LES GOUTS DES AUTRES, LES ACTIVITÉS QUOTIDIENNES**

Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche
Communication Exprimer ses goûts, parler de ses loisirs, justifier un choix, exprimer une envie -
Lexique le temps libre et les loisirs, les saisons, les activités quotidiennes, le temps (le matin, le soir, la nuit)

UNIT IV

9 Hours

COMPRENDRE SON ENVIRONNEMENT SOUVENIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs démonstratifs, le passé composé, l'imparfait
Communication Proposer à quelqu'un de faire quelque chose, raconter une sortie au passé, parler d'un film
Lexique Les sorties, la famille, l'art, les vêtements et les accessoires

UNIT V

9 Hours

GOUTER A LA CAMPAGNE

Grammaire La forme négative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantité
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 Français, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Préparation à l'examen du DELF A1 Hachette
4. Réussir le DELF A1 Bruno Girardeau
5. Website: Français Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Français Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001

21ME001 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)

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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Identify engineering design principles and problem identification for product development.
2. Select suitable concept to design effectively for various engineering problems.
3. Prepare the detailed design process and design for manufacture and assembly.
4. Make process plan for production based on quality function deployment and value engineering.
5. Make concept sketch and scheme drawing for report preparation and intellectual property right.

Articulation Matrix

C O 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			2										1		
2			2				2						1		
3		2												2	
4			2				2						1	2	
5					2									2	

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 Assemblies: 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

21ME002 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 impart knowledge on polymer matrix composites. To expose the characteristics and different fabrication techniques of 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Identify suitable reinforcement and matrix materials for different applications.
2. Select appropriate fabrication technique for specific application of polymer matrix composite.
3. Select suitable processing method for the fabrication of metal matrix composites.
4. Select suitable fabrication method for specific application of ceramic matrix composite.
5. Understand the mechanics involved in composite material.

Articulation Matrix

C O 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			1									2	
2	3	2		2	2									2	
3	3	2			2									2	
4	3	2			2									2	
5	3	2			2							1		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)

7. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, MarceDekker Inc, 2007
8. K. Autar Kaw, Mechanics of Composite Materials, CRC Press, 2013.
9. B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, JohWiley and Sons, New York, 2017.
10. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2016.
11. K.K. Chawla, Composite materials, Springer Verlag, 2012
12. Robert M. Jones, Mechanics Of Composite Materials, CRC Press,2018.

21ME003 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the fundamentals of CAD and geometric transformation concepts.
2. Describe the various representations of geometric curves, surfaces and solids.
3. Identify the importance of visual realism algorithms.
4. Identify the significant factors in computer aided assembly.
5. Explain the geometrical model data exchange and transfer CAD Models between various platforms.

Articulation Matrix

C O 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	2												2		
2	2	1											2		
3	2	1											2		
4	3	2											3		
5	2	1											3		

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>

21ME004 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain basic elements of vibration of Single Degree of Freedom (SDF) systems.
2. Calculate the natural frequency of vibration of Two Degree of Freedom (TDF) systems.
3. Estimate the natural frequency of vibration of Multi Degree of Freedom (MDF) systems.
4. Perform vibration analysis for vibration of continuous systems.
5. Select suitable instruments and control methods for measurement and control of vibration.

Articulation Matrix

C O 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	1										2		
2	3	2	1										2		
3	3	2	1	2						1			2		

4	3	2	1										1		
5	1	2	2		2					1		1		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 - Responses 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 - Orthogonality 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>.

21ME005 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.

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

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the fundamental concepts of friction and wear
2. Identify the appropriate surface contact characteristics for particular applications
3. Apply the characteristics of friction for tribological applications
4. Analyze the wear mechanism and measure wear rate
5. Select suitable lubrication type for particular application

Articulation Matrix

C O 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	1					1						3		
2	2	1					1				1		2		
3	2	2					1						2		
4	2	2					1					1	3		
5	2	1					1					1	3		

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. Elastohydrodynamic 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/>

21ME006 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Recognize the common engineering failure mechanisms
2. Understand the mechanics of fracture and different theories of fractures
3. Study of dynamic fracture toughness of materials
4. Analyse the wear failure and wear measurement techniques
5. Study the technique, tools and procedure of root cause failure analysis and failure mode effective analysis

Articulation Matrix

C O 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	3	3	1								1	3		
2	3	2	3	2								1	3		
3	3	3	3	2								2	3		
4	3	3	2	2	2							2	3		
5	3	3	3	1	2							2	3		

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.

**21ME007 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 introduce 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Understand the principles of heating, ventilation and air conditioning
2. Evaluate the heat load in a building envelope considering the factors responsible for heat gain and heat loss
3. Evaluate and select components required for an air distribution system
4. Evaluate and select components required for a chilled water circulation
5. Drafting the HVAC System for erection with detailed instructions

Articulation Matrix

C O 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	2	3			3								2		
2	2	2	3		2					1		2	2		
3	2	2	3		2	2				1		2	3		
4	2	2	3		2	2				1		2	3		
5	2		3		2	2				3		3	3		

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

21ME008 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Design the sand moulding process gating system
2. choose the suitable casting process for the given component and explain the advanced casting process
3. Explain the centrifugal casting and die casting process
4. Select the suitable bulk deformation process based on application.
5. Explain the sheet metal forming processes and make simple sheet metal components.

Articulation Matrix

C O 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	1									2		2	
2	2	2	2									2		2	
3	2	2										2		2	
4	2	2	1									2		2	
5	2	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 twinning - 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

21ME009 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the basics of non-traditional machining processes
2. Select the suitable mechanical energy based non-traditional machining processes for the given industrial applications.
3. Find the suitable machining processes for machining electrically conductive materials.
4. Choose appropriate chemical and electro-chemical energy based processes for precision machining
5. Select the suitable thermal energy based process for cutting and machining of the hard materials.

Articulation Matrix

C O 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	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

7 Hours

NON TRADITIONAL MACHINING PROCESS

Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet machining(AJM), Water jet machining(WJM), Ultrasonic machining(USM), Electric discharge machining(EDM), 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, New York, 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

21ME010 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the working principle of welding process and selecting parameters for the given applications.
2. Select the suitable Resistance welding techniques for industrial requirements.
3. Identify the suitable technique to suit the welding requirement of the components.
4. Understand the need for the special techniques suitable automation for the special materials.
5. Understand the welding symbol, welding metallurgy and Weldability of special metals to design and test to have sound weld

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	1			1	1									
2	2	1	1	2	1	1									
3	2	1	1	1	1	1	1						1	1	

4	2	1	1	1	1	1	1							1	1	
5	2	1	1	1	1	1	1							1	1	

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

21ME011 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the concepts of process planning and cost estimation.
2. Assess the importance of cost estimation process and its procedures.
3. Compute direct, indirect and over head expenses
4. Determine the production cost of forging, welding, and foundry.
5. Find the machining time for Lathe, drilling, boring, shaping, milling and grinding operations

Articulation Matrix

C O 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	2	2							1		1	1	1	1	
2	3	2						1	1		1	1	1	1	

3	2	2	2					1	2		1	1	1	2	
4	3	2	2					2	1		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

21ME012 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Assess CAD/CAM integration for changing manufacturing and management scene.
2. Construct a machine cell using the concepts of Group Technology and Computer Aided Process Planning
3. Select the suitable material handling and storage system for Flexible Manufacturing Systems.
4. Choose the suitable CIM implementation and data communication techniques.
5. Use various protocols and database terminology in CIM.

Articulation Matrix

C O No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	2	2			1									2	
2	2	2			1									2	
3	2	2			1									2	
4	2	2			1									2	
5	2	2			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

21ME013 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

C O 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	2	2	2		2							2	1	2	
2	2	2	2		2							2	1	2	
3	2	2	2		2							2	1	2	

4	2	2	2		2							2	1	2	
5	2	2	2		2							2	1	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**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.Pharm, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2015.
5. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, 2015.

21ME014 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the concept and scope of operations management in a business context.
2. Select the appropriate forecasting techniques to forecast the demand.
3. Find the suitable workplace by facility location attributes.
4. Implement the aggregate planning and master scheduling for effective utilization of the resources.
5. Use the principles of material management and inventory control.

Articulation Matrix

C O 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		3
2	3	3	3									2	1		3
3	3	2	3									3	2		3
4	3	3	3									3	1		3
5	3	3	3									3	1		3

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, McGraw Hill Publication, International Edition, 1987.
6. Everett E. Adams, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India Publications, Fourth Edition, 1989.

21ME015 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Demonstrate knowledge on logistics and supply chain management tools and techniques
2. Plan and organize retail distribution logistic systems.
3. Carry out order management and reverse logistics.
4. Evaluate the role of logistics drivers and contemporary practices.
5. Organize the functions of warehouse management.

Articulation Matrix

C O 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	1					2		2						2	
2						2		3			2			2	
3	2				2									2	
4	1													2	
5						1	2	2						2	

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.

21ME016 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Use the concepts, dimension of quality and philosophies of TQM
2. Apply the principles of TQM and its strategies in industries
3. Apply the statistical quality tools and seven management tools
4. Choose the suitable TQM tools for continuous improvement
5. Use the concept of QMS, EMS and EnMS in industries

Articulation Matrix

C O 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	1					2		3					1	1	1
2						2		3			2		1	1	
3	2		1		2								1	2	2
4	1		2										2	1	1
5						1	2	2					1	1	

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

21ME017 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Exemplify the basic lean manufacturing concepts, principles and its tools
2. Elucidate the concepts of plant layout and techniques for improving the productivity
3. Explain the various quality improvement tools such as TQM, 5S and VSM
4. Classify the basic concepts of six sigma and its tools
5. Apply the six sigma methodologies in various industrial fields

Articulation Matrix

C O 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	2	3	2											2	
2	2	3	2	2										2	
3	2	3	2											2	
4	2	3	2											2	
5	2		2	2										2	

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

21ME018 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Understand the concept of engineering economics, types of costs and make economic analysis.
2. Apply various interest formulae and their applications for different investment situations.
3. Analyze various investment alternatives and make appropriate decisions.
4. Make replacement and market analysis to take optimal decisions.
5. Understand the macro economics and inflation.

Articulation Matrix

C O 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	2	2	2					1							3
2	2	2	2					1	1						3
3	1	2	2	2	2										3
4	1	2	2	2	2					1					3
5	1	2	2	2						1					3

UNIT I**9 Hours****INTRODUCTION**

Introduction to Micro and Macro economics - 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

21ME019 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the statistical and analytical methods to track the results of a process.
2. Explain the acceptance sampling principles and methods.
3. Determine the effect of each of the explanatory variables on the response variable.
4. Demonstrate the extent of an improvement made to a process.
5. Determine the short term stability and capability of a process.

Articulation Matrix

C O 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								3
2	3	2				2	2					2			3
3	3	2				2	2					2			3
4	3	3			2	2	2					2			3
5	3	3			2	2	2					2			3

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

21ME020 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.

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the working principle of steam power plant and boilers.
2. Assess the function of various systems in steam power plant.
3. Select the suitable components for nuclear power plants and hydel power plants.
4. Expose the working of diesel and gas turbine power plant.
5. Explain the different sources of renewable energy and calculate the economics of power plants.

Articulation Matrix

C O 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	2	2				1	2							3	
2	2	-					1							3	
3	2					1	2							3	
4	2					1	1							3	
5	2	3	2				1				-			3	

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.

21ME021 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the principle of refrigeration systems.
2. Select the components and working of vapor compression refrigeration systems
3. Demonstrate the working of various refrigeration systems
4. Determine the parameters involved in design of air conditioning systems.
5. Explain the installation, charging, servicing and applications of refrigerant and air-conditioning system

Articulation Matrix

C O 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	2	2				2	2								2
2	2	2				2	2								2
3	2					2	2								2
4	2	2			2	2	2								2
5	2	2			2	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.

21ME022 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Outline various forms of energy and its conservation techniques.
2. Illustrate the different types of energy audits followed in industry
3. Investigate the efficiency enhancement techniques of thermal utilities.
4. Analyse the efficiency of electrical utilities.
5. Evaluate the performance of industry based on energy

Articulation Matrix

C O 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	2					2	2								2
2	2				2	2	2					2			2
3	2	2	2	2		2	2								
4	2	2			2	2	2					2			2

5	2	2			2	2	2					2			2
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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 Wulfinhoff, 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

21ME023 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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the fundamental principles of compressible flow.
2. Resolve the problems on isentropic flow through variable area ducts, Fanno flow and Rayleigh flow.
3. Assess the effect of flow properties on normal shock.
4. Explain the basic gas dynamics theories for aircraft propulsion systems.
5. Demonstrate the working of solid propellant and liquid propellant rocket engines.

Articulation Matrix

C O 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	2	3												-	3
2	2	3				2						2		-	3
3	2	3				2						2		-	3
4	2	3				2						2		-	3
5	2	3			-	2						2		-	3

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, choking 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 Hugoniot 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.

21ME024 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.

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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Understand the solar radiation, and its conversion into heat using solar collectors.
2. Explain the working concept of solar photovoltaic system for any isolated applications.
3. Expose the energy conversion process of wind energy and bio energy.
4. Illustrate the fundamentals concepts of ocean thermal energy systems and geothermal thermal energy systems.
5. Update their knowledge in the field of hydrogen and fuel cells.

Articulation Matrix

C O 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	2		2	2		2	3						2		2
2	2		2	2		2	3						2		2
3	2		2	2		2	3						2		2
4	2		2	2		2	3						2		2
5	2		2	2			3					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.

FOR FURTHER READING

Design of Solar Thermal Systems, PV Panel Sizing, Economic Analysis of Wind Energy, Need for Hybrid Systems, Fuel cell Hybrids

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.

21ME025 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.

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Formulate the fundamental governing equations of fluid mechanics and heat transfer.
2. Solve the fluid dynamics problems using finite difference method.
3. Construct finite volume equations for steady and unsteady state diffusion type problems.
4. Apply the finite element methods for fluid flow problems.
5. Generate the grids using grid generation techniques for simple, complex geometries and create the turbulence. modelling different flow situations

Articulation Matrix

C O 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	2	3												3	
2	2	3		2	2										3
3	3	2			2										3
4	2	3			2										3
5	3	3			2	2	2	2				2			3

UNIT I**9 Hours****INTRODUCTION TO CFD**

Introduction - Applications and impact of CFD in diverse fields - Navier-Stokes 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 inviscid 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**

Overview 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. Introduction to computational fluid dynamics <http://nptel.ac.in/courses/112105045/>

21ME026 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the design aspects of jigs and fixtures
2. Identify the suitable locators and clamps for jigs, fixtures and press tools
3. Design a suitable jig for producing a part of the given component.
4. Design a suitable fixture for producing the given component.
5. Design a suitable press tool dies and Press tools for the given simple components.

Articulation Matrix

C O 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	1	2	2	2									2		
2	1	2	2	2									2		
3	1	2	2	2									2		
4	1	2	2	2									2		
5	1	2	2	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

21ME027 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the coordinate system for the development of geometric models.
2. Develop and manipulate the curves and surfaces using parametric equations.
3. Demonstrate and manipulate the solid models using different modeling approaches.
4. Implement the transformation and projection over the geometric model.
5. Determine the neutral file formats over 2D wireframe models.

Articulation Matrix

C O 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								3
2	3	2				2	2					2			3
3	3	2				2	2					2			3
4	3	3			2	2	2					2			3
5	3	3			2	2	2					2			3

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.

21ME028 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 design a 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply ergonomics principles to the creation of safer, healthier and more efficient and effective activities in the workplace.
2. Apply ergonomics human information input and workstations to fit employees
3. Identify appropriate risk reduction measures to reduce ergonomic risks
4. Apply ergonomics principle to the design of workplace layout and design of equipment
5. Appreciate environmental aspects of good ergonomic design

Articulation Matrix

C O 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	1	1	2				2	2		2			1	2	
2	1	1	2				2	2		2			1	2	
3	1	1	2				2	2		2			1	2	
4	1	2	2				2	2		2			1	2	
5	1	2	2				2	2		2			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

Text Book(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.

**21ME029 PRODUCT DATA AND LIFE CYCLE
MANAGEMENT**

3 0 0 3

Course Objectives

- To build 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 teach about 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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. To implement Product Life Cycle Management concepts in development of products with the help of Internet
2. To demonstrate the data management of specific project / process in an industry
3. To apply the product life cycle management in product depended business automation
4. To create the virtual reality model of product development using unique technique
5. To analyze the results of integrating PLM with CAD & ERP in product development

Articulation Matrix

C O 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	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.

**21ME030 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Analyse a new product based on the various roles in a typical NPD Process followed in Industry
2. Evaluate the value of a product and to select the appropriate product design tool for the specific product
3. Apply and demonstrate the Engineering Change Management process for a product
4. Design metallic and non metallic products under DFMA concepts to reduce machining time and manufacturing cost also considering the environmental impact
5. Create prototype by performing the reverse engineering techniques

Articulation Matrix

C O 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	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			2	1	

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/>

**21ME031 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.

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply geometric dimensioning and tolerancing techniques in engineering drawing
2. Select appropriate design considerations to minimize difficulty to produce components by casting, welding and forming processes
3. Use the design for manufacturing concept to reduce machining time and manufacturing cost
4. Analyze and design the parts for easy assembly using DFA guidelines
5. Design the components by considering the product life cycle and its environmental impact

Articulation Matrix

C O 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	2	2	1		1							1		2	
2	2	2	1									1		2	
3	2	2	1									1		2	
4	2	2	1									1		2	
5	2	2	1				2					1		2	

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, Clampability, 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.

21ME032 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. To select the appropriate automation technology for a particular industrial sector.
2. To develop PLC programs using different programming techniques.
3. To configure a SCADA system to monitor and control an industrial process
4. To analyze the security of a DCS system against potential threats.
5. To evaluate the effectiveness of security measures in protecting a communication system

Articulation Matrix

C O 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	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

21ME033 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Select the components and recognize the specifications of an Industrial Robot.
2. Apply forward and inverse kinematics and DH convention for predicting the position and orientation of serial manipulator.
3. Analyse the velocity kinematics and static force of serial manipulator robot.
4. Analyse the dynamics and plan the trajectory for industrial robot
5. Create an algorithm for mobile robot control by applying suitable controlling techniques.

Articulation Matrix

C O 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	1	1	1		2	1								3	
2	3	3	3		2	1								1	
3	3	3	2		3	1								2	
4	3	3	2		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.

21ME034 AUTOMATION SYSTEM DESIGN**3 0 0 3****Course Objectives**

- To understand the need for automation across a range of industrial sectors.
- To learn about the numerous technological advancements in industrial automation, including motion components, transfer lines, and high-speed assembly.
- To execute the design in an 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Outline the need of automation in industries.
2. Select the motion components from the manufacturers for particular applications.
3. Illustrate different instructions available in an automated assembly line for various applications
4. Assess the product design automation for high speed automatic assembly.
5. Integrate the simulation approach and to differentiate the CIROS over other automation systems for design and implementation.

Articulation Matrix

C O 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	1		2										2	1	
2	3	2	1											3	2
3	3	2	1											3	2
4	3	2	3											3	2
5	3	2	1											3	2

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 Comprehensive Guide to Servo Motor Sizing", Copperhill Technologies Corporation, Massachusetts, 2007.

21ME035 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Choose the right material handling systems with safety and efficiency.
2. Select appropriate hoists and winches for the given application.
3. Compare different conveyors and elevators and select appropriate material handling for given working conditions.
4. Analyze appropriate lifting mechanisms to improve material handling.
5. Design various material handling systems based on the working environments.

Articulation Matrix

C O 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	2		1										3		
2	3		2										1		
3	3		2										2		
4	3		2										2		
5	3		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 equipments like pallets, bins, racks, decking, order picking, positioning equipments

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.

21ME036 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Represent the function of intelligent agents with the problem reduction.
2. Select an appropriate paradigms for any type of AI problem
3. Choose the topological method to decide path planning technique.
4. Indicate the localization technique to explore map planning.
5. Design applications for Natural Learning Process that uses Artificial Intelligence.

Articulation Matrix

C O 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	1	1											1		
2	1	1													
3	2	1													
4	3	3	2										2	2	
5	1	3	2											2	

UNIT I

8 Hours

INTRODUCTION 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.

21ME037 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Differentiate the basics of supervised and semi supervised learning methods
2. Retrieve the unsupervised and reinforcement learning methods involved in artificial learning
3. Interpret the concept of artificial neural networks and their control applications
4. Implement the fuzzy knowledge representation and multi objective decision making controllers
5. Compute the knowledge about various heuristic and non heuristic algorithms.

Articulation Matrix

C O 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	1		3		1								3		2
2	1		3		1								2	2	
3	2	2	3		1								2	2	
4	3	2	2		3								2	2	
5	1		1		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

21ME038 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional details of various automobile components
2. Illustrate the function of fuel supply and engine auxiliary systems
3. Illustrate the function of various components in transmission and drive lines of a vehicle.
4. Exemplify the types of steering system, and braking system.
5. Interpret the functioning of suspension system and emission control systems.

Articulation Matrix

C O 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	2	3	1		3									2	
2	2	2	1		3									2	
3	2	2	1		3									2	
4	2	3	2		2									2	
5	2	2	2		2									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.

21ME039 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Identify the current trends of automotive electronics systems
2. Exemplify the current trends of automotive electrical systems
3. Select appropriate automotive Sensors and Actuators for modern automobiles
4. Understand Interfacing of sensors and actuators using RTOS
5. Analyse the communication protocol suitable for automobile

Articulation Matrix

C O 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	2	2											2		
2	3	3	3		3								3		
3	2												2		
4	3	3	2		3								3		
5	2												3		

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). McCulloch-Pitts neuron, Linear separability, Hebb network. Perceptron Network, Adaline, Medialine. 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 (µC/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, Understanding Automotive Electronics- An Engineering Perspective, The Boulevard, Langford Lane, Kidlington, Oxford, 2017.
3. Barry Holmbeak, 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

21ME040 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the current scenario of demand for fossil fuels, effects of automobile pollution and strategy of next generation vehicles
2. Identify the requirements of Electric Drive train for hybrid and electric vehicles
3. Select appropriate electric motor and drive controls for EVs and HEVs
4. Analyze the performance of energy storage systems in electric and hybrid vehicles.
5. Select appropriate Fuel Cell Technology for EVs and HEVs.

Articulation Matrix

C O 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	3	3		2	2							1		
2	3	3	3									1	2		
3	3	3	3		1								2		
4	3	3	3				2						2		

5	3	3	3									1	2		
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UNIT I**9 Hours****INTRODUCTION**

Usage Pattern of Automobiles in cities and highways, Air Pollution: NO_x, 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 Lory, Electric Vehicle Technology-Explained, New York: John Wiley & Sons Ltd., 2012
6. <https://nptel.ac.in/courses/108103009/>

21ME041 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply laws of mechanics to calculate dynamic, road loads and equation motion
2. Analyze gradeability, tractive force, braking force and stopping distance of a vehicle
3. Modeling the passenger car suspension of a vehicle
4. Analyze the cornering and braking effort of a tire
5. Apply steady state cornering model to design the steering system of a vehicle

Articulation Matrix

C O 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	3	3									2	3		
2	3	3	3									2	3		
3	3	3	3									2	2		
4	3	3	3										2		
5	3	3	3										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/>

21ME042 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Understand evolution of automotive electronic and connected vehicle concepts
2. Apply the knowledge for selection of sensor and communication protocols for interfacing sensors
3. Apply knowledge of Computer Vision and Deep learning in autonomous vehicle
4. Apply fundamentals of Localization and Path planning in autonomous vehicle
5. Explain the intelligent systems associated with Autonomous vehicle

Articulation Matrix

C O 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	2	2	2		3								2	2	
2	2	2	3		3								3	3	
3	3	3	3		3								3	3	
4	3	3	3		3								3	2	
5	2	2	2		3								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, ISBN#1-4018-8659-0, 2006
6. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN#1-4018-4339-5, 2003

21ME043 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Compare the maintenance practices, safety and tools used in workshop.
2. Explain the engine and engine subsystem maintenance procedure.
3. Summarise the transmission and driveline maintenance procedure.
4. Explain the steering, brake, suspension and wheel maintenance maintenance procedure.
5. Summarise the electrical and air conditioning maintenance procedure.

Articulation Matrix

C O 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	2	2	3										2		
2	2	2	2										2		
3	2	3	2										3		
4	2	2	3										2		
5	2	3	2										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- Workshop 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 AND WHEEL 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

21MEH01 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the concepts of process planning and cost estimation.
2. Assess the importance of cost estimation process and its procedures.
3. Compute direct, indirect and over head expenses
4. Determine the production cost of forging, welding, and foundry.
5. Find the machining time for Lathe, drilling, boring, shaping, milling and grinding operations

Articulation Matrix

C O 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	2	2							1		1	1	1	1	
2	3	2						1	1		1	1	1	1	
3	2	2	2					1	2		1	1	1	2	

4	3	2	2					2	1		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.Elanchezian, 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

21MEH02 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Outline various forms of energy and its conservation techniques.
2. Illustrate the different types of energy audits followed in industry
3. Investigate the efficiency enhancement techniques of thermal utilities.
4. Analyse the efficiency of electrical utilities.
5. Evaluate the performance of industry based on energy

Articulation Matrix

C O 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	2					2	2								2
2	2				2	2	2					2			2
3	2	2	2	2		2	2								
4	2	2			2	2	2					2			2

5	2	2			2	2	2					2			2
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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

21MEH03 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.

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

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the fundamental concepts of friction and wear
2. Identify the appropriate surface contact characteristics for particular applications
3. Apply the characteristics of friction for tribological applications
4. Analyze the wear mechanism and measure wear rate
5. Select suitable lubrication type for particular application

Articulation Matrix

C O 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	1					1						3		
2	2	1					1				1		2		
3	2	2					1						2		
4	2	2					1					1	3		
5	2	1					1					1	3		

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. Elastohydrodynamic 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/>

21MEH04 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Compare the maintenance practices, safety and tools used in workshop.
2. Explain the engine and engine subsystem maintenance procedure.
3. Summarise the transmission and driveline maintenance procedure.
4. Explain the steering, brake, suspension and wheel maintenance maintenance procedure.
5. Summarise the electrical and air conditioning maintenance procedure.

Articulation Matrix

C O 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	2	2	3										2		
2	2	2	2										2		
3	2	3	2										3		
4	2	2	3										2		
5	2	3	2										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- Workshop 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 AND WHEEL 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

21MEH05 AUTOMATION SYSTEM DESIGN**3 0 0 3****Course Objectives**

- To understand the need for automation across a range of industrial sectors.
- To learn about the numerous technological advancements in industrial automation, including motion components, transfer lines, and high-speed assembly.
- To execute the design in an 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.

PSO1. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Outline the need of automation in industries.
2. Select the motion components from the manufacturers for particular applications.
3. Illustrate different instructions available in an automated assembly line for various applications
4. Assess the product design automation for high speed automatic assembly.
5. Integrate the simulation approach and to differentiate the CIROS over other automation systems for design and implementation.

Articulation Matrix

C O 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	1		2										2	1	
2	3	2	1											3	2
3	3	2	1											3	2
4	3	2	3											3	2
5	3	2	1											3	2

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 Comprehensive Guide to Servo Motor Sizing", Copperhill Technologies Corporation, Massachusetts, 2007.

21MEH06 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Assess CAD/CAM integration for changing manufacturing and management scene.
2. Construct a machine cell using the concepts of Group Technology and Computer Aided Process Planning
3. Select the suitable material handling and storage system for Flexible Manufacturing Systems.
4. Choose the suitable CIM implementation and data communication techniques.
5. Use various protocols and database terminology in CIM.

Articulation Matrix

C O 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	2	2			1									2	
2	2	2			1									2	
3	2	2			1									2	
4	2	2			1									2	
5	2	2			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

21MEH07 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.

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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Explain the design aspects of jigs and fixtures
2. Identify the suitable locators and clamps for jigs, fixtures and press tools
3. Design a suitable jig for producing a part of the given component.
4. Design a suitable fixture for producing the given component.
5. Design a suitable press tool dies and Press tools for the given simple components.

Articulation Matrix

C O 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	1	2	2	2									2		
2	1	2	2	2									2		
3	1	2	2	2									2		
4	1	2	2	2									2		
5	1	2	2	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

21MEH08 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Illustrate the coordinate system for the development of geometric models.
2. Develop and manipulate the curves and surfaces using parametric equations.
3. Demonstrate and manipulate the solid models using different modeling approaches.
4. Implement the transformation and projection over the geometric model.
5. Determine the neutral file formats over 2D wireframe models.

Articulation Matrix

C O 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								3
2	3	2				2	2					2			3
3	3	2				2	2					2			3
4	3	3			2	2	2					2			3
5	3	3			2	2	2					2			3

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.

21MEH09 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 design a 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.

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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply ergonomics principles to the creation of safer, healthier and more efficient and effective activities in the workplace.
2. Apply ergonomics human information input and workstations to fit employees
3. Identify appropriate risk reduction measures to reduce ergonomic risks
4. Apply ergonomics principle to the design of workplace layout and design of equipment
5. Appreciate environmental aspects of good ergonomic design

Articulation Matrix

C O 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	1	1	2				2	2		2			1	2	
2	1	1	2				2	2		2			1	2	
3	1	1	2				2	2		2			1	2	
4	1	2	2				2	2		2			1	2	
5	1	2	2				2	2		2			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

Text Book(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.

**21MEH10 PRODUCT DATA AND LIFE CYCLE
MANAGEMENT**

3 0 0 3

Course Objectives

- To build 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 teach about 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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. To implement Product Life Cycle Management concepts in development of products with the help of Internet
2. To demonstrate the data management of specific project / process in an industry
3. To apply the product life cycle management in product depended business automation
4. To create the virtual reality model of product development using unique technique
5. To analyze the results of integrating PLM with CAD & ERP in product development

Articulation Matrix

C O 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	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.

**21MEH11 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Analyse a new product based on the various roles in a typical NPD Process followed in Industry
2. Evaluate the value of a product and to select the appropriate product design tool for the specific product
3. Apply and demonstrate the Engineering Change Management process for a product
4. Design metallic and non metallic products under DFMA concepts to reduce machining time and manufacturing cost also considering the environmental impact
5. Create prototype by performing the reverse engineering techniques

Articulation Matrix

C O 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	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			2	1	

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/>

**21MEH12 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.

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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply geometric dimensioning and tolerancing techniques in engineering drawing
2. Select appropriate design considerations to minimize difficulty to produce components by casting, welding and forming processes
3. Use the design for manufacturing concept to reduce machining time and manufacturing cost
4. Analyze and design the parts for easy assembly using DFA guidelines
5. Design the components by considering the product life cycle and its environmental impact

Articulation Matrix

C O 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	2	2	1		1							1		2	
2	2	2	1									1		2	
3	2	2	1									1		2	
4	2	2	1									1		2	
5	2	2	1				2					1		2	

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, Clampability, 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.

21MEM01 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the concept and scope of operations management in a business context.
2. Select the appropriate forecasting techniques to forecast the demand.
3. Find the suitable workplace by facility location attributes.
4. Implement the aggregate planning and master scheduling for effective utilization of the resources.
5. Use the principles of material management and inventory control.

Articulation Matrix

C O 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		3
2	3	3	3									2	1		3
3	3	2	3									3	2		3
4	3	3	3									3	1		3
5	3	3	3									3	1		3

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, McGraw Hill Publication, International Edition, 1987.
6. Everett E. Adams, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India Publications, Fourth Edition, 1989.

21MEM02 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Demonstrate knowledge on logistics and supply chain management tools and techniques
2. Plan and organize retail distribution logistic systems.
3. Carry out order management and reverse logistics.
4. Evaluate the role of logistics drivers and contemporary practices.
5. Organize the functions of warehouse management.

Articulation Matrix

C O 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	1					2		2						2	
2						2		3			2			2	
3	2				2									2	
4	1													2	
5						1	2	2						2	

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.

21MEM03 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.

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Use the concepts, dimension of quality and philosophies of TQM
2. Apply the principles of TQM and its strategies in industries
3. Apply the statistical quality tools and seven management tools
4. Choose the suitable TQM tools for continuous improvement
5. Use the concept of QMS, EMS and EnMS in industries

Articulation Matrix

C O 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	1					2		3					1	1	1
2						2		3			2		1	1	
3	2		1		2								1	2	2
4	1		2										2	1	1
5						1	2	2					1	1	

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

21MEM04 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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Exemplify the basic lean manufacturing concepts, principles and its tools
2. Elucidate the concepts of plant layout and techniques for improving the productivity
3. Explain the various quality improvement tools such as TQM, 5S and VSM
4. Classify the basic concepts of six sigma and its tools
5. Apply the six sigma methodologies in various industrial fields

Articulation Matrix

C O 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	2	3	2											2	
2	2	3	2	2										2	
3	2	3	2											2	
4	2	3	2											2	
5	2		2	2										2	

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

21MEM05 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Understand the concept of engineering economics, types of costs and make economic analysis.
2. Apply various interest formulae and their applications for different investment situations.
3. Analyze various investment alternatives and make appropriate decisions.
4. Make replacement and market analysis to take optimal decisions.
5. Understand the macro economics and inflation.

Articulation Matrix

C O 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	2	2	2					1							3
2	2	2	2					1	1						3
3	1	2	2	2	2										3
4	1	2	2	2	2					1					3
5	1	2	2	2						1					3

UNIT I**9 Hours****INTRODUCTION**

Introduction to Micro and Macro economics - 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

21MEM06 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.

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.

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. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain the statistical and analytical methods to track the results of a process.
2. Explain the acceptance sampling principles and methods.
3. Determine the effect of each of the explanatory variables on the response variable.
4. Demonstrate the extent of an improvement made to a process.
5. Determine the short term stability and capability of a process.

Articulation Matrix

C O 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								3
2	3	2				2	2					2			3
3	3	2				2	2					2			3
4	3	3			2	2	2					2			3
5	3	3			2	2	2					2			3

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

**18ME0XA GEOMETRIC DIMENSIONING AND
TOLERANCING**

1 0 0 1

Course Objectives

- To understand the basics of GD&T and its practical applications
- To understand the proper way to specify dimensions and tolerances, symbols, datum, position, location, run out and profile

Course Outcomes (COs)

1. Classify the standards and fundamentals of limits, fits and tolerance. 2. Explain the rules and symbols of dimension and tolerance in various products
2. Explain the rules and symbols of dimension and tolerance in various products

UNIT I

15 Hours

GEOMETRIC DIMENSIONING AND TOLERANCING

Introduction to Geometric Dimensioning and Tolerancing - Dimensioning and Tolerancing Fundamentals -Symbols, Terms, and Rules-Datum Application, Datum feature identification-Inclined, cylindrical datum feature. Form flatness, straightness, circularity, cylindricity - Position Maximum Material Condition, Least material Condition - Location - Position, Coaxiality - Concentricity Symmetry Exercises - Run out - Definition, circular run out, total run out Profile Definition, Specifying profile, radius refinement with profile of conical feature.

Total: 15 Hours

Reference(s)

1. Gene R Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design, McGraw Hill, 2006
2. Alex Krulikowski, Fundamentals of Geometric Dimensioning and Tolerancing, Delmar Cengage Learning, 1997
3. Gary K Griffith, Geometric Dimensioning and Tolerancing: Application and Inspection, Prentice Hall, 2001.

18ME0XB LEAN MANUFACTURING

1 0 0 1

Course Objectives

- To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a lean environment
- To understand the terminology relating to lean operations in both service and manufacturing organizations

Course Outcomes (COs)

1. Summarize the quality requirements to provide products and services in lean environment
2. Implement technologies related lean operations and its significance in manufacturing processes

NIT I

15 Hours

LEAN MANUFACTURING

History Evolution - Toyota production system - Lean manufacturing overview - Work place organization - Visual controls - Pull production and cellular manufacturing - Value flow pull - Value and perfection lean Mapping the present Mapping the future - Product and process development Value stream analysis - Over production - Waiting - Work In Progress - Transportation – Inappropriate processing - Excess motion or ergonomic problems - Defected products - Under- utilization of employees - Just In Time - Kanban tooling - Total Productive Maintenance 5S – Single Minute Die Exchange - Lean six sigma - Flow charting - Identifying and eliminating unnecessary steps - Setup time - reduction approaches - Steps in implementing lean strategy Lean accounting system

Total: 15 Hours

Reference(s)

1. Dennis P Hobbs, Lean Manufacturing Implementation, J. Ross Publications, 2004
2. Jeffrey K Liker, The Toyota Way-14 Management Principles, Mc-Graw Hill, New York, 2004

18ME0XC PIPING ENGINEERING

1 0 0 1

Course Objectives

- To impart knowledge on piping processes.
- To create expertise in Preparation of Plot Plan-Preparation of Equipment Layouts

Course Outcomes (COs)

1. Construct the process diagram for piping network
2. Plan the process layouts and design efficient piping systems

UNIT I

15 Hours

PIPING ENGINEERING

Introduction to Piping, Process Diagrams (PFD, UFD, P&ID, Line List etc) Pipe Fittings- Pipe Flanges, Valves and Piping Special Items -Various codes and standards used in power and process industries-. Overview of Technical Queries and Technical Bid Evaluations - Preparation of Plot Plan-Preparation of Equipment Layouts-Preparation of Piping General Arrangement Drawings-Preparation of Cross Sectional Drawings-Piping Isometric Drawings-Material Take off-Preparation of Piping Material Specification-, Valve Material Specification-Pipe Wall thickness Calculations-Branch reinforcement calculations-Introduction to Stress Analysis-Types of stresses-Significance of forces and moments in piping system-Expansion Loop and Bellows-Pipe Supports-Support Types-Support Selection-Support Location-Support Span Calculation

Total: 15 Hours

Reference(s)

1. Sam Kannappan, Introduction to piping stress analysis, John Wiley & sons, 2006.
2. Mohinder L. Nayyar, Piping Engineering Hand book, McGraw Hill, 2000.

18ME0XD PROBLEM SOLVING TECHNIQUES

1 0 0 1

Course Objectives

- To understand the basic concepts of quality control method of problem solving
- To create an awareness and understanding of quality control tools & techniques

Course Outcomes (COs)

1. Explain the quality control method of problem solving techniques.
2. Carry out quality control measures using the quality control tools & techniques

UNIT I

15 Hours

PROBLEM SOLVING TECHNIQUES

Quality Control Tools and story -seven steps of story -seven quality control tools-problem definition - observation - analysis - solution identification - actions and execution - checking - standardization - case study -basic problem solving.

Total: 15 Hours

Reference(s)

1. L. Suganthi and Anand A Samuel, Total Quality Management, PHI Learning, 2009.

18ME0XE AUTOMOTIVE EXHAUST SYSTEM

1 0 0 1

Course Objectives

- To understand the concepts and design of exhaust systems and catalytic converters
- To disseminate information about various types of exhaust systems and strategies relevant to Indian automotive industry
- To identify the various factors to be considered for selection of exhaust manifold system

Course Outcomes (COs)

1. Explain the various factors influencing the performance of exhaust systems and catalytic converters
2. Execute design and modeling of exhaust manifold systems
3. Implement the CFD tool to improve the automotive exhaust systems

UNIT I

15 Hours

AUTOMOTIVE EXHAUST SYSTEM

Exhaust system - Exhaust system Function -Parts - Types - Catalytic Converter - Types - 2 way - 3 way
CATCON Mufflers - Types - Principles - Design trade off - BS IV and above norms - EGR - SCR- EGR
Function - Pollution control - SCR - Function -Pollution control - CATIAV5 application for Exhaust system
- Modeling - Assembly - Drafting - Basics with Exhaust manifold modeling practical session - CFD analysis
- Uniformity index - Space velocity - Flow analysis - Pressure drop - CPSI optimization

Total: 15 Hours

Reference(s)

1. Dr. Kirpal Singh, Automobile Engineering (Volume II), Standard publishers distributors.
2. Ronald M. Heck, Robert J. Farrauto and Suresh T. Gulati, Catalytic Air Pollution Control: Commercial Technology, Wiley, 3rd Edition, 2009.

18ME0XF CONTINUOUS IMPROVEMENT

1 0 0 1

Course Objectives

- To acquire the general knowledge to deliver consistently high quality and value added products and services to the customer in a Manufacturing environment
- To understand the terminology relating to continuous improvement in manufacturing organizations

Course Outcomes (COs)

1. Identify the continuous improvement metrics
2. Understand and appreciate various tools applied and methodology adopted to run a KAIZEN event

UNIT I

15 Hours

CONTINUOUS IMPROVEMENT

History -Evolution - Toyota production system - Lean Manufacturing - Fundamentals, Importance, Definitions, Phases, Lead time - Supplier - Manufacturer - Customer Chain, Work place organization - Visual controls - Pull production and cellular manufacturing -Waste identification - Over production - Waiting - Work In Progress - Transportation - Inappropriate processing - Excess motion or ergonomic problems - Defected products - Under utilization of employees - Organizations Vision, Mission, Strategy Deployment and Key performance Indicators. Importance of Measurement. Gap Analysis, Identification of KAIZEN projects. Methodology, team formation, Problem statement, Data collection, Brainstorming, Analysis, containment action, corrective action and preventive action. Overview of performance metrics visual control

Total: 15 Hours

Reference(s)

1. Dennis P Hobbs, Lean Manufacturing Implementation, J. Ross Publications, 2004
2. Jeffrey K Liker, The Toyota Way-14 Management Principles, Mc-Graw Hill, New York, 2004

18ME0XG INDIAN PATENT LAW

1 0 0 1

Course Objectives

- To make students familiar about Indian patent law
- To make the students find the patentability of any invention
- To make the students aware of legal background of various process of Indian Patent

Course Outcomes (COs)

1. Summarize the various provisions of Indian Patent Law
2. Find patentability of any invention
3. Assess the legal provisions of Indian patent system

UNIT I

15 Hours

INDIAN PATENT LAW

Preliminary, Inventions Not Patentable, Applications for Patents, Publication and Examination of Applications, Opposition Proceedings to Grant of Patents, Anticipation, Provisions for Secrecy of Certain Inventions, Grant of Patents and Rights Conferred Thereby, Patents of Addition, Restoration of Lapsed Patents, Surrender and Revocation of Patents, Register of Patents, Patent Office and Its Establishment, Powers of Controller Generally, Working of Patents, Compulsory Licenses and evocation, Central Government, Suits Concerning Infringement of Patents, Appeals to the Appellate Board, Penalties, Patent Agents, International Arrangements

Total: 15 Hours

Reference(s)

1. Indian Patent Act ,1970
2. Indian Patent Rules,2003

18ME0XH RAILWAY TRACK TECHNOLOGY

1 0 0 1

Course Objectives

- To familiar about Indian Railway and types
- To understand the Railway track and its types.

Course Outcomes (COs)

1. Summarize Indian Railway system and types of rails
2. Explain Railway track system

UNIT I

15 Hours

RAILWAY TRACK TECHNOLOGY

Indian Railway overview, Evolution, Structure, Grades, Coning of Wheels and Caning of Rails, Types of Rails, Rail Material, Rail Joints, Sleepers, Rail and Sleeper Fastening, Railway Curves, Track Maintenance, Modern Track Construction, Track Inspection, High Speed Tracks and Special Tracks, Derailment Investigations.

Total: 15 Hours

Reference(s)

1. Railway Track Engineering, Fourth Edition, by J.S. Mundrey, McGraw Hill Education (India) Private Limited, 2009.

18ME0XI GLASS ENGINEERING

1 0 0 1

Course Objectives

- To understand the basics of Glass making and various types in real world practice
- To understand the applications of commercial and special purpose glasses for various engineering applications

Course Outcomes (COs)

1. Classify glasses and select suitable glass for suitable engineering application.
2. Explain the glass making and treatment processes in a glass Industry.

UNIT I

15 Hours

GLASS ENGINEERING

Introduction, History of Glass, Raw Materials & Manufacturing Process, Glass Properties, Care and Storage, Glass Processing, Types of glass based on application, Float Glass, Processed Glasses - (Laminated Safety Glass, Heat Treated Glass, Curved Toughened Glass, Insulated Glass), Reflective & Coated Glass, Special Purpose Glasses for fire resistance, bullet proof & sound proof requirements, Decorative Glass, Standards and Testing, Fields of application - applied engineering - facades - selection of glass for facades.

Total: 15 Hours

Reference(s)

1. Glass Engineering Handbook, by Errol Bertram Shand (Author), W. H. Armistead (Foreword), Literary Licensing, LLC (May 19, 2012)
2. Introduction to Glass Science and Technology , Royal Society of Chemistry, James E Shelby, 12 Jan 2005

**18ME0XJ PLASTICS-
DESIGN,PROCESSING,TOOLING,ASSEMBLY AND
TESTING**

1 0 0 1

Course Objectives

- To know the various plastic materials used in Automotive, home appliance, Medical fields
- To Understand the basic and advanced methods of plastic processing and the tooling & equipments used for it.
- To learn various post processing requirements such as painting, foiling, pad printing.
- To learn the various plastic joining processes and plastic testing methods.

Course Outcomes (COs)

1. Classify the plastic material and its applications
2. Explain the plastic processing methods & machine, tooling used for it
3. Indicate the post processing requirements and its significance
4. Assess the plastic joining processes characteristics

UNIT I

15 Hours

PLASTICS - DESIGN, PROCESSING, TOOLING, ASSEMBLY AND TESTING

Introduction on Plastics, Types of plastics - Thermo plastics, Thermo setting plastics, Applications in Automobiles, Home appliances etc., Basic concepts on plastic design, Mould flow analysis Plastic processing- Preheating, Molding, Molding types - Injection molding, compression molding, Roto molding, 2K molding, Tooling- Core, Cavity, Inserts, heating & cooling circuits, Tool materials, Molding machines - Types, Tonnage & other specifications. Molding defects -Warping, Catching, Weld line, burning, Sink marks etc, Method of avoiding defects Post molding process- Annealing, Texturing, color foiling, Pad printing, Painting etc., Assembly of Plastics- Ultrasonic welding, Heat sinking, Vibration welding. Testing of Plastics-UV testing, scratch resistance, Flammability, Resistance against chemicals, impact test.

Total: 15 Hours

Reference(s)

1. Hand book of Plastic Technologies - Charles A Harper
2. Plastic Engineering - R.J Crawford
3. Plastic Materials and Processes-A Concise Encyclopedia - Charles A. Harper & Edward M. Petrie

**18ME0XK 5S-INTRODUCTION AND
IMPLEMENTATION**

1 0 0 1

Course Objectives

- To impart the knowledge on 5S fundamental and implementation concepts
- To provide the 5S training for implementation in engineering fields

Course Outcomes (COs)

1. Demonstrate various steps of 5S implementation principles
2. Practice 5S in real time life and engineering fields

UNIT I

15 Hours

5S - INTRODUCTION AND IMPLEMENTATION

Need for implementing 5S and advantages-Explanation on 5S- methodology -zone formation, individual responsibility, hidden and common area and no man- land-Introduction to SEIRI-Tagging system, Disposal Policy, SEIRI Museum - 1S Practical - Introduction to SEITON -PEEP, Points for Storage, Safety, Quantity Identification - 2S Practical - Introduction to SEISO-Cleaning methods, Schedules, Accessories, Responsibilities - 3S Practical, Introduction to SEIKETSU - Evolving Standard Practices, Visual Controls - 4S Practical- Introduction to SHITSUKE- Self audit, Check lists. Evaluation - 5S Practical, Management audit, Jagruthi groups, Motivation, Awards, manuals.

Total: 15 Hours

Reference(s)

1. 5S's : Five Keys to a Total Quality Environm, Takashi Osada, 2003
2. 5 Pillars of the Visual Workplace : The Sourcebook for 5S Implementation, Hiroyuki Hirano, 2019

18ME0XL ENERGY AUDITING AND INSTRUMENTS

1 0 0 1

Course Objectives

- To acquire knowledge about various thermal and electrical energy audit instruments used in the field as per Bureau of Energy Efficiency, Govt. of India
- To gain the skill in using the Energy Audit Instruments for field measurements

Course Outcomes (COs)

1. Apply the measurement skill of energy related parameters in industrial environment
2. Interpret the measurements for its accuracy and genuineness
3. Express the analytical skill in quantification of energy flow in and out of an energy system

UNIT I

15 Hours

ENERGY AUDITING AND INSTRUMENTS

Introduction to Energy Conservation Act 2001, Basics of Energy Audit, Instruments : Clip on power meter, Infrared Thermometer, Vane Anemometer, Pitot tube with digital pressure meter, Stroboscope, Hygrometer, Combustion efficiency Monitor, Light Meter, Specifications, Limitations, applications and measurement calculations for Pressure, flow (Air and Water), power consumption, waste heat recovery calculations.

Total: 15 Hours

Reference(s)

1. CO2 Emission Mitigation through Energy Conservation- A Practical Guide. b y Dr. M. Thirugnanasambandam, Published by Shanlax Publishers- 2018.
2. Energy Audit Manual published by Energy Management Centre, Govt of Kerala , Kerala – Manual-2017.

18ME0XM INDUSTRIAL CONTROL VALVES

1 0 0 1

Course Objectives

- To understand the basics of control valves and its applications
- To understand the global market outlook, competition, growth in industries and job opportunities in a global scale

Course Outcomes (COs)

1. Explain the basics of control valves, manufacturers, global presence and market outlook.
2. Interpret the control valves application in industries like power plant and compressors

UNIT I

15 Hours

INTRODUCTION TO CONTROL VALVES

Introduction-Principle of control valve-Classification of control valve-application of control valve-advantages and disadvantages of control valve in power plant and compressor industries-The makers in global scale-Indigenized control valves makers in India-Market overlook and trends-Job opportunities.

Total: 15 Hours

Reference(s)

1. Control Valves, Guy Borden, 1998
2. Control Valves: Practical Guides for Measurement and Control by Guy Borden (Editor)

18ME0XN INDUSTRIAL GEAR BOX DESIGN

1 0 0 1

Course Objectives

- To provide knowledge of industrial gear design and safety of gear safety
- To understand the lubrication systems and heat treatment of gears
- To impart the knowledge on gear life calculation for planetary gear

Course Outcomes (COs)

1. Explain the basics of gears and gear boxes.
2. Design the gear box for industrial applications

UNIT I

15 Hours

INDUSTRIAL GEARBOX DESIGN

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

Reference(s)

1. Gustav Niemann Machine elements, Design and Calculation in Mechanical Engineering, Volume-II-Gears- Translated by K. Lakshminarayanan, M.A. Parameswaran and G.V.V. Rayudu.
2. Handbook of Gear Design, by Gitin M Maitra section edition, Tata McGraw Hil

**18ME0XO PRODUCT VALIDATION TECHNIQUES
AND ENVIRONMENTAL TESTING**

1 0 0 1

Course Objectives

- To know the new product development processes & its various stages
- To learn various standards followed in product validation processes
- To Understand the basic and advanced methods of Product validation techniques

Course Outcomes (COs)

1. Explain the product development process and its importance
2. Classify the different standards for product validation
3. Explain various product validation techniques
4. Indicate the acceptance and rejection criteria based on test outcome

UNIT I

15 Hours

TESTING AND REPORTS

Introduction on Product development process & its stages. Product validation and its importance. Standards adopted for testing like ISO, ASTM, JIS, MIL, DIN. Mechanical Test-Tensile, compressive, impact, Torsional, Fatigue, Creep, Vibration, Shock tests, drop test, Scratch resistance. Chemical test-chemical resistance, corrosion resistance test, Flammability test; Environmental test-Temperature storage, Humidity storage, Thermal cycling, thermal shock, solar radiation, UV effects, water ingress protection, Dust ingress protection, Altitude test, readability test. Electrical tests-EMI test, steady state electrical environment test. Test facility used for various test, Testing environments, maintenance & calibration of testing equipment's, acceptance & rejection criteria based on test outcomes, test report, NABL accreditation and its importance.

Total: 15 Hours

Reference(s)

1. Tomer Sharon, "Validating Product Ideas Through User Lean Research", Rosanfeld, 2016.
2. Dennis F.X. Mathaisel, "Engineering for Sustainability", CRC Press, 2013

18ME0XP 8D PROBLEM SOLVING METHODOLOGY

1 0 0 1

Course Objectives

- To understand the 8D problem solving methodology.
- To implement 8D problem solving methodology using 7QC Tools.

Course Outcomes (COs)

1. Explain the step by step 8D problem solving methodology
2. Apply the 7 QC Tools in 8D problem solving methodology to solve simple industrial problems

UNIT I

15 Hours

PROBLEM SOLVING METHODOLOGY

Problem Solving Methodology Concept and Advantages- 8D Problem Solving Methodology - Why - Why Analysis -7 QC Tools -Stratification, Pareto Diagram, Cause and Effect Diagram, Check Sheet, Control Chart/Graph, Histogram, Scatter Diagram Practical Applications of 8D Problem Solving Methodology & 7 QC Tools.

Total: 15 Hours

Reference(s)

1. L.Suganthi and Anand A Samuel, Total Quality Management, PHI Learning, 2009.

**18ME0XQ ADVANCED PRODUCT QUALITY
PLANNING**

1 0 0 1

Course Objectives

- To acquire the knowledge on advanced product quality planning
- To understand the terminology relating to APQP and PPAP

Course Outcomes (COs)

1. Explain advanced product quality planning and its advantages.
2. Explain the product approval process

UNIT I

15 Hours

ADVANCED PRODUCT QUALITY PLANNING

APQP -Basic concept, Elements, Five phases of APQP, Process flow, QFD, FMEA and Control plan. PPAP -Process flow diagram, Process capability study report, Design records & engineering change notes, Sub contractor control and Corrective & preventive actions

Total: 15 Hours

Reference(s)

1. D H Stamatis, Advanced Product Quality Planning, Taylor & Francis, 2001

18ME0XR DESIGN OF ROTOR SHAFTS

1 0 0 1

Course Objectives

- To understand types of screw compressor types, and rotor shafts design procedure used in industrial applications.
- To acquire the knowledge of shafts to support and transmit power, procedure of bending and twisting moments, equivalent bending and torsion in the screw compressor rotors.
- To know the importance of stress-concentration raisers and method of reducing the same, by calculating the stress concentration factors on static and fatigue basis.
- To learn use of the standard templates and tools to design the shafts

Course Outcomes (COs)

1. Classify the types of shafts and its applications
2. Explain the use of several components fitted on to the shafts
3. Calculate the stress levels in the shaft and arrive an optimum design with adequate factor of safety
4. Assess the importance of stress-concentration elements in shaft design
5. Components assembly methods theory, calculation, and disassembly procedure.

UNIT I

15 Hours

DESIGN OF ROTOR SHAFTS

Introduction on Screw Compressors, Types, Machine Elements, Types of Shafts – Introduction, applications screw compressors, Industrial and Automotive segments. Shear force, bending and twisting moment diagram for various types of Shafts- theory, example calculations and practices for screw compressors. Calculation of different types of stress levels across the shaft containing coupling, bearings, gears, etc. Calculation of equivalent bending and torsional moments - design the shaft with adequate safety factor. Features which causes stress concentration, method of calculating the stress concentration factors in static and fatigue basis. Standard templates used for the calculation of stress concentration factors and design of shafts. Corrected endurance limit by using standard ANSI / ASME - B106.1M-1985. Method of components assembly - theory and calculation and disassembly procedure.

Total: 15 Hours

Reference(s)

1. Compressor Handbook: Principles and Practice Tony Giampaolo, MSME, PE, CRC Press
2. Screw Compressor Modelling, Design and Use, City University, London
3. COMPRESSOR HANDBOOK Paul C. Hanlon McGRAW-HILL
4. Bearings in twin screw compressors, Application handbook, SKF
5. Design of Machine Elements Book by V. B. Bhandari
6. A Textbook of Machine Design Textbook by J.K. Gupta and R.S. Khurmi
7. Mechanical Design Second Edition By Peter R. N. Childs
8. Standard ANSI/ASME B106.1M-1985,

18ME0XS SAFETY MANAGEMENT IN INDUSTRY

1 0 0 1

Course Objectives

- To understand the procedure for accident prevention.
- To study the methods of safety performance monitoring.

Course Outcomes (COs)

1. Perform task with due consideration to Industrial Safety.
2. Identify the fire accident, preventive, control measure and prepare emergency preparedness plan and conduct a Mock drill.

UNIT I

15 Hours

Safety audit – shop floor, electrical, excavation, scaffolding- Measurement of noise, light, temperature and personal air sampling and analysis - ISO 14001 and ISO 45001. Fire prevention – science of combustion, classes of fire, types of fire- fire detection and control- smoke and flame detector, alarm system, hydrant, sprinkler- portable extinguishers- selection and operation - emergency preparedness and mock drill.

Total: 15 Hours

Reference(s)

1. National Safety Council, Accident Prevention Manual for Industrial Operations, N. S. C. Chicago, 1988.
2. H.W Heinrich, Prevention Industrial Accident McGraw-Hill Company, New York, 1991.
3. IS 14489: - code of practice on occupational safety and health.
4. ISO 14001: - environment management system.
5. ISO 45001: - Health safety management system.
6. Handbook of fire technology, R S Gupta, orient blackswan, 2010.

18ME0XT MODELLING AND ANALYSIS OF UNDERWATER ROBOTS

1 0 0 1

Course Objectives

- To understand the basics of underwater robots and its practical applications.
- To understand the design concepts and simulation of vehicle structure.

Course Outcomes (COs)

1. Classify the underwater design concepts and its applications.
2. Explain the geometry and behaviour of underwater robots.

UNIT I

15 Hours

Introduction to Underwater Robots - Conceptual design - Basic components and structure of underwater robots. Propulsion systems and locomotion mechanisms. Buoyancy and stability considerations. Material selection and waterproofing techniques. - Modeling of Pressure hull and pressure canister - Modeling of skeletal frame - Assembly of Underwater robots. Fluid Flow Simulation - Navier-Stokes equations - robot's geometry - Boundary conditions. Drag and Hydrodynamics - drag forces - hydrodynamic forces and moments - flow patterns and pressure distribution.

Total: 15 Hours

Reference(s)

1. Dr. Steven W. Moore, Harry Bohm, and Vickie Jensen, Underwater Robotics: Science, Design & Fabrication, Marine Advanced Technology Education (MATE) Center, 2010.
2. Sabiha Wadoo, Pushkin Kachroo ·Autonomous Underwater Vehicle Modeling, Control Design and Simulation, CRC Press, 2017

18ME0XU IOT INTEGRATED AUTOMATION SYSTEMS

1 0 0 1

Course Objectives

- To understand the knowledge about Industrial Automation using modern machines.
- To integrate the internet of things with automation systems.
- To develop IoT integrated automation systems with modern visualizations platforms.

Course Outcomes (COs)

1. To design a process automation for an Industry
2. To design a simulation model using Codesys and Factory IO

UNIT I

15 Hours

Industrial Automation Components – Factory Automation & Process Automation. Data manipulations and Acquisition in PLC: Analog sensors Types and Interfacing with PLC - Acquire value from pressure, temperature, flow with ESP32/Raspberrypi/PLC - Modules and Sensors Interfacing (IR sensor, Ultrasonic sensors, Soil moisture sensor) using Raspberry pi/node mcu - Modules and Actuators Interfacing (Relay, Motor, Buzzer) using Raspberry pi/node mcu - Configure and communicate MCU with PLC - Bluetooth, I2C, SPI, RFID, Ethernet, Modbus - SCADA and storage in Local PC / Server - Pneumatic application control and monitor using Arduino through Cloud. Design and practices: Pneumatics, Electropneumatics, Hydraulics, and Electrohydraulics. Programming techniques of a controller: PLC programming - Instruction lists. Ladder diagram and sequential function chart programming techniques, HMI programming, VFD & Servo programming. Hands-on practices of IOT: IOT application in controlling a load through intranet & internet - MQTT Communication - Industrial IoT Application through Case study - PLC control in Industrial applications - Grabbing the content from a web page, Sending data on the web. Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance.

Total: 15 Hours

Reference(s)

1. Introduction to PLCs, Second Edition 2nd Edition Jay F. Hooper, 2006.
2. PLC Controls with Ladder Diagram (LD): IEC 61131-3 and introduction to Ladder programming Tom Mejer Antonsen, 2021.
3. Create projects using Codesys & Factory IO.

18ME0XV AUTONOMOUS KINEMATICS AND CONTROL IN ROS

1 0 0 1

Course Objectives

- Understand 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.

Course Outcomes (COs)

1. Design the kinematic model for Mobile Robot in ROS platform.
2. Create the navigation and path planning algorithm for mobile robots in ROS gazebo.

UNIT I

15 Hours

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. 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

21OCS01 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.

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.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

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

UNIT I**8 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**8 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

POLYMORPHISM AND FILE STREAMS

10 Hours

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

10 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.

21OCS02 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.

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.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

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

**21OCS03 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.

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.

Course Outcomes (COs)

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

Articulation Matrix

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

21OCS04 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.

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

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

21OCS05 SOCIAL TEXT AND MEDIA ANALYTICS**3 0 0 3****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.

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.

Course Outcomes (COs)

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

Articulation Matrix

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

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 Shneiderman, 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

21OEC01 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.

Course Outcomes (COs)

1. Apply the diodes and transistors in regulators and amplifiers and analyze their characteristics.
2. Illustrate the working of analog IC with different configurations and its applications.
3. Simplification of Boolean expressions using K-map and implementation of combinational circuits.
4. Analyze the Flip flops and memory configurations in digital circuits.
5. Classify and analyze A/D and D/A converters with its parameters.

Articulation Matrix

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

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.

21OEC02 MICROCONTROLLER PROGRAMMING**3 0 0 3****Course Objectives**

- Understand Series of Microcontrollers in terms of architecture, Programming and Interfacing.
- Learn Programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers
- 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.

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.

Course Outcomes (COs)

1. Interpret the components and functionalities of 8051 Microcontrollers.
2. Develop microprocessor applications using the Assembly Language Program
3. Illustrate the working nature of PIC microcontroller on various versions
4. Illustrate the interfacing of different peripherals using PIC Microcontroller
5. Analyze the architecture and instruction set of ARM Microcontroller

Articulation Matrix

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

21OEC03 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.

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
1	3	2	2									
2	3	2										
3	3	2										
4	2	2	2									
5	3	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 and PM 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 OPTICAL COMMUNICATION

Satellite Communication Systems-Keplers Law, LEO and GEO Orbits, footprint, Link model- Optical Communication 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.

21OEC04 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.

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
1	1	2	1	1								
2	1	2	2	3								
3	1	1	2	3								
4	1	1	3									
5	1	2	3	3								

UNIT I

9 Hours

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology ; Communication Services: Serial and Parallel, Synchronous and Asynchronous, 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. Schaffer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

21OEI03 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.

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
1	3	3	1	1										
2	3	3	2	2	2					2	2	2		
3	2	2	2	1										
4	3	3	3	1	2					1	2	2		
5	3	2	2	1	2				-	1	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

VI's and sub-VI's, 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.

21OEI04 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.

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	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
1	3	2	1											
2	3	2	1	2										
3	3	2	1											
4	3	2	2	2										
5	3	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 cords, 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.

21OBT01 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.

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.

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1		2				3								1
2	2						1								3
3	1						3								2
4	2						3								3
5	1						1								

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

21OFD01 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.

Course Outcomes (COs)

1. Justify 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. Differentiate Traditional fermented foods products based on its raw material
4. Implement 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
1	1													
2		1												
3	2	1	1											
4								2						
5								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 TRADITIONAL 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.

21OFD02 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.

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
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
1	1	2	1											
2		1				1	2	1						
3		1												
4	1	2												
5	1	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 residues - 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

21OFD03 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.

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

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

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.

21OFD04 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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

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

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.

21OFT01 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. Design, analyse and evaluate the performance of mechanical systems.

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
1	3	1	3				2		2	2		2	2	
2	3	2	3				1		2	3		2	2	
3	3	2	3				2		2	3		2	2	
4	3	2	3				2		2	3		2	2	
5	3	2	3				2		2	3		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>

21OFT02 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. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop 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. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

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

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>

21OFT03 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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

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
1	2	3	2					1						
2	2	3	2						2				2	2
3	2	3	2		3								2	2
4	2	2	2						2				2	2
5	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>

21OPH01 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.

Course Outcomes (COs)

1. Summarize the origin and advance of nanomaterials and its classification
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Explain the physical properties exhibited by nanomaterials
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
1	1	1												
2	2	2												
3	3	1												
4	1	1												
5	2	3												

UNIT I**9 Hours****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.

UNIT II**9 Hours****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.

UNIT III

9 Hours

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.

UNIT IV

9 Hours

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

UNIT V

9 Hours

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", Imperial 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, Aulice Scibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

21OPH02 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.

Course Outcomes (COs)

1. Exemplify the band gap, drift and diffusion current densities due to carrier transport in semiconductors
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Illustrate the operation of Bipolar Junction transistor at different modes and different configurations
4. Illustrate the operation of metal oxide field effect transistor and their memory devices
5. Represent the working mechanism of opto-electronic devices

Articulation Matrix

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

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-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

21OPH03 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.

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
1	2	1												
2	1	2												
3	2	1												
4	2	1												
5	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. Thiagarajan 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

21OPH04 BIO-PHOTONICS**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.

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

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues.
2. Identify the properties of different optical instruments in biological systems to represent their behavior in structure and design of detection engineering instruments.
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
1	3	2												
2	3	2												
3	3	2							3					
4	3	2							3					
5	3	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

BIO-NANO-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.

21OPH05 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 properties 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.

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
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
1	2	1												
2	2	1												
3	2	2												
4	2	2												
5	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.

**210CH01 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.

Course Outcomes (COs)

- Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
- Compare different corrosion types on metals when exposed to air, water and at high temperatures ($> 100\text{ }^{\circ}\text{C}$)
- Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
- Calculate the rate of corrosion on metals using electrochemical methods of testing
- Propose 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
1	2	1												
2	2						1							
3	1	3												
4	2	2												
5	3	3					1							

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 diagrams 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>

210CH02 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.

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different 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
1	2	1												
2	1	2												
3	2	2												
4	1	1	2											
5	1	3	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.>

210CH03 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.

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

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

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

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.

21OMA01 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.

Course Outcomes (COs)

1. Recognize 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

C O 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	1	2													
2	1	3													
3	2	3													
4	2	3													
5	3	3													

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.

221GE01 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)

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

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.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

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				
3									2		2				
4									3		2				
5									2		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.

21OGE02 ENTREPRENEURSHIP DEVELOPMENT I**3 0 0 3****Course Objectives**

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

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.

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.

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyse the different modes of operation management.

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****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

21OGE03 ENTREPRENEURSHIP DEVELOPMENT II**3 0 0 3****Course Objectives**

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

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.

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.

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyse the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

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****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>

21OGE04 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.

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.

Course Outcomes (COs)

1. Understand religio-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

C O 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	2		1				1					3			
2	2		2				2					2			
3	2		1				1					2			
4	2		3				3					3			
5	2		1				1					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 – coping 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-Padmasana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvangasana, Halasana etc. 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

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

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/>

21OME01 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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

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								1	2	
2	2	2	2	2	2								1	2	
3	2	2	2	2	2								1	2	
4	2	2	2	2	2								1	2	
5	2	2	2	2	2								1	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.Pharm, 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

21OME02 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.

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. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth 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

21OME03 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.

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.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

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	1							2	
4	1	2	1		2	2	2							2	
5	2	2	2		1	1	1							2	

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.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

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.

21OME04 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

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. Design, analyse and evaluate the performance of mechanical systems.

PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Explain safety management system of an industry.
2. Implement the provisions of acts and rules in industries.
3. Implement and review the safety performance followed in various industries
4. Evaluate safety appraisal in chemical industries.
5. Generate safety reports on construction industries.

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			3					2	1	
3	2											3	1		2
4	2	3							2				2		1
5					2					3				3	

UNIT I

10 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

10 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

10 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

8 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

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

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.