B.E. (Mechanical Engineering)

Revised 2018 Regulations, Curriculum & Syllabi

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

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CONTENTS

VISION OF THE DEPARTMENT

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

MISSION OF THE DEPARTMENT

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

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

PROGRAM OUTCOMES (PO)

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

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

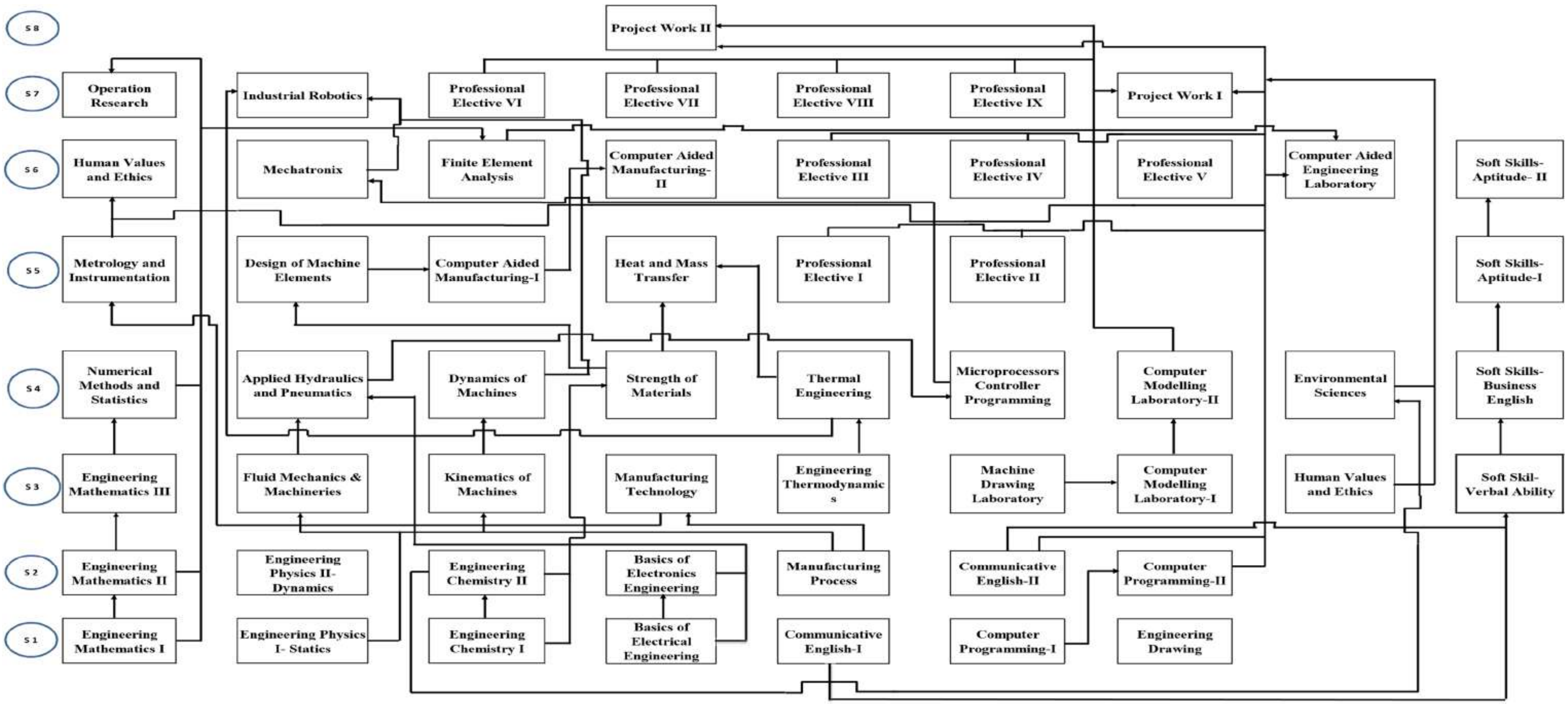
1. Design, analyse and evaluate the performance of mechanical systems.
2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost
3. Address all the fluid flow and energy transfer related problems of mechanical systems.

CORRELATION OF PEOs WITH POs AND PSOs

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

DEPARTMENT OF MECHANICALENGINEERING
CURRICULAM DESIGN & INTERLINKING O COURSES

360 º FLEXIBLE LEARNING FRAME WORK



(Candidates admitted during the Academic Year 2021-2022)

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
							CIA	SEE	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
							CIA	SEE	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
18ME206	COMPUTER PROGRAMMING II	0	0	4	2	4	100	0	100	ES
Total		**12**	**2**	**12**	**20**	**26**	**-**	**-**	**-**	**-**

III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	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
							CIA	SEE	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**
							CIA	**SEE**	**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 - APT ITUDE 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**
							CIA	**SEE**	**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**
							CIA	**SEE**	**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	60	40	100	EEC
Total		**17**	**1**	**8**	**22**	**26**	**-**	**-**	**-**	**-**

VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**SEE**	**Total**	
21ME801	PROJECT WORK II	0	0	18	9	18	60	40	100	EEC
Total		**0**	**0**	**18**	**9**	**18**	**-**	**-**	**-**	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	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
							CIA	SEE	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 MANAGEMENT	3	0	0	3	3	40	60	100	PE
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)										
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**
							CIA	**SEE**	**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
18ME0XU	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**
							CIA	**SEE**	**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
21OPH04	BIOPHOTONICS	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**
							CIA	**SEE**	**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
CIA - Continuous Internal Assessment
SEE - Semester End 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.

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

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

Course Outcomes (COs)

1. Apply the concepts of complex numbers, vectors, and matrices to solve engineering and mathematical problems.
2. Intrepret the application of limits, continuity, differentiation, and integration to solve various engineering problems
3. Assess the various integration techniques, including substitution, integration by parts, and partial fractions, to solve application-based problems involving algebraic and transcendental functions.
4. Analyze extreme values, points of inflection, and apply optimization techniques, along with solving problems involving areas, volumes, and lengths of curves and solids using various methods.
5. Investigate the concepts of analytic functions, their properties, the determination of these functions using Milne-Thomson's method, and evaluate integrals in the 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	2	-	-	-	-	-	-	-	-	-	-	-	-	2
3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	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 2 0 2 3

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.

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

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

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

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

Course Outcomes (COs)

1. Apply the fundamental principles of mechanics and force systems to analyze static equilibrium of particles.
2. Assess the effects of moments and couples on rigid bodies and simplify force-couple systems.
3. Analyze the solutions for rigid body equilibrium problems in two and three dimensions, including trusses, beams, and frames.
4. Develop methods to determine the properties of surfaces and solids, such as centroid, area, volume, and moment of inertia.
5. Investigate the behavior of objects on inclined planes by applying the laws of friction in ladder, wedge and rolling friction.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	2	-	-	-	2	-	-
2	3	-	-	-	-	-	-	-	2	-	-	-	2	-	-
3	2	3	2	-	-	-	-	-	2	-	-	-	2	-	-
4	2	2	3	-	-	-	-	-	2	-	-	-	2	-	-
5	2	2	2	2	-	-	-	-	2	-	-	-	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 **7 Hours**

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.

UNIT IV **6 Hours**

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.

UNIT V **6 Hours**

FRICTION

Origin of friction - types - laws of friction - friction on horizontal and inclined planes, ladder and wedge friction - rolling resistance.

EXPERIMENT 1 **3 Hours**

Experimental verification of parallelogram law

EXPERIMENT 2 **3 Hours**

Experimental verification of Lamis theorem

EXPERIMENT 3 **4 Hours**

Experimental demonstration of principles of moments using bell crank lever apparatus.

EXPERIMENT 4 **3 Hours**

Determination of equilibrant force using polygon law of forces

EXPERIMENT 5 **4 Hours**

Experimental study of equilibrium of forces in concurrent co-planar systems.

EXPERIMENT 6 **3 Hours**

Experimental analysis of the reaction forces of a simply supported beam and compare the same with analytical results.

EXPERIMENT 7 **3 Hours**

Determination of centroid of laminas.

EXPERIMENT 8 **3 Hours**

Determination of moment of inertia of plane area.

EXPERIMENT 9 **4 Hours**

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.Hibbeller, 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 **2 0 2 3**

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.

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. Apply the concept of atomic structure and bonds to understand the metallic structure and properties
2. Analyze the metal-alloy system by applying the phase rule and condensed phase rule
3. Design appropriate alloy compositions for specific engineering applications by analyzing the purpose of alloying, functions and effects of alloying elements.
4. Construct TTT diagram and cooling curves for heat treatment processes in steels to achieve desired mechanical properties.
5. Evaluate the characteristics of chemical samples using UV, IR, and colorimetric spectroscopic techniques

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	-
3	2	2	2	-	-	2	-	-	-	-	-	-	-	2	-
4	2	2	-	-	-	2	-	-	-	-	-	-	-	2	-
5	2	-	-	-	-	2	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) Ã¢?? 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.

EXPERIMENT 1 **2 Hours**

Instruction about safety rules, reagent handling and precautions need to be followed in lab.

EXPERIMENT 2 **4 Hours**

Measurement of grain size using optical metallurgical microscope.

EXPERIMENT 3 **4 Hours**

Estimation of copper content in brass by EDTA method.

EXPERIMENT 4 **4 Hours**

Microstructure analysis of steel/cast iron.

EXPERIMENT 5 **4 Hours**

Microstructure analysis of stainless steel

EXPERIMENT 6 **4 Hours**

Microstructure analysis of aluminium/copper

EXPERIMENT 7 **4 Hours**

Determination of hardenability using Jominy end quench test.

EXPERIMENT 8 **4 Hours**

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, Materals 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.

Programme Outcomes (POs)

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

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

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

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

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

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 the concepts of electrical elements and measuring instruments in simple electrical circuits
2. Analyze the electrical properties of engineering materials by applying standard testing procedures and laws
3. Investigate the operational characteristics of static and dynamic electrical machines used in engineering applications
4. Assess the performance and suitability of various electrical drives for different industrial and domestic scenarios.
5. Implement engineering knowledge to select appropriate components for electrical installations, including protection devices and wiring systems

Articulation Matrix

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

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.

EXPERIMENT 1 6 Hours

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

EXPERIMENT 2 6 Hours

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

EXPERIMENT 3 6 Hours

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

EXPERIMENT 4 6 Hours

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

EXPERIMENT 5 6 Hours

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, Shyammohan 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)

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

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

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

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

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

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

PSO1.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 appropriate grammar and vocabulary expected at the BEC Preliminary exam level.
2. Analyze the general meaning of non-routine letters within one's work area, and short reports of a predictable nature.
3. Design straightforward, routine letters of a factual nature, and develop notes on routine matters, such as taking/placing orders.
4. Create simple presentations/demonstrations to enhance understanding.
5. Infer the predictable requests from visitors, state routine requirements, and offer advice within one's 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	3	-	-	-	-	-	-	-	3	3	-	2	2	2	-
2	2	2	-	-	-	-	-	-	3	3	-	2	2	2	-
3	1	2	2	-	-	-	-	-	3	3	-	2	2	2	-
4	1	2	2	-	-	-	-	-	3	3	-	2	2	2	-
5	2	-	-	-	-	-	-	-	3	3	-	2	2	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.

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.

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. Apply fundamental data types and operators to perform arithmetic and logical operations in C programs.
2. Develop conditional and looping control structures to solve basic decision-making and repetitive problems.
3. Design programs using arrays and string functions to manage structured data efficiently.
4. Create user-defined data types like structures and functions, including recursion, to organize code logically.
5. Analyze control flow using switch cases, jumping statements, and loops to improve program behavior.

Articulation Matrix

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

EXPERIMENT 1 **6 Hours**
Implement a C program which include a fundamental data types Integer, Float, Double and Character.

EXPERIMENT 2 **6 Hours**
Implement a C program to perform the arithmetic operations using primitive data types.

EXPERIMENT 3 **6 Hours**
Implementation of logical, relational, bitwise, increment/decrement and Conditional Operators in C.

EXPERIMENT 4 **3 Hours**
Implementation of simple if else Conditional Statement.

EXPERIMENT 5 **3 Hours**
Implementation of nested if else Conditional Statement.

EXPERIMENT 6 **3 Hours**
Implementation of Switch Case Statement.

EXPERIMENT 7 **3 Hours**
Implement a C program using for Looping Statement.

EXPERIMENT 8 **3 Hours**
Implement a C program using Do-While Looping Statement.

EXPERIMENT 9 **3 Hours**
Implement a C program using While Looping Statement.

EXPERIMENT 10 **3 Hours**
Implementation of Jumping Statements

EXPERIMENT 11 **3 Hours**
Implementation of One Dimensional Array.

EXPERIMENT 12 **3 Hours**
Implementation of Two Dimensional Array.

EXPERIMENT 13 **3 Hours**
Implement a C program to perform String Manipulation Functions.

EXPERIMENT 14 **6 Hours**
Implement a C program using structures.

EXPERIMENT 15 **6 Hours**
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.

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.

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

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

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

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

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

PSO1. 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 engineering drawing standards by practicing lettering, numbering, dimensioning, and conic sections to understand its fundamental concepts.
2. Analyse the concept of projection and plot the points projections in all four quadrants and lines projection in the first quadrant.
3. Interpret the projections of basic planes and solids by changing their positions step by step.
4. Design and construct the cut sections and surface layouts of simple and truncated solids using different types of cutting planes.
5. Illustrate the orthographic and isometric views of basic machine components to develop visualization and orthographic drawing skills.

Articulation Matrix

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

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 Venugpoal, 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.

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. Apply partial differentiation in mechanical engineering contexts such as heat flow, stress-strain analysis, and fluid dynamics, and illustrate their behavior using graphs.
2. Infer the double and triple integrals to calculate area, volume, mass, and center of gravity in Cartesian coordinates
3. Investigate and solve first-order differential equations (separable, homogeneous, exact, Bernoulli's) to model mechanical engineering systems like fluid flow, heat transfer, and vibrations.
4. Analyze first-order differential equations such as separable, homogeneous, exact, and Bernoulli's to model mechanical systems like fluid flow, heat transfer, and vibrations
5. Develop solutions to second-order differential equations with constant coefficients using methods like undetermined coefficients, series solutions of differential equations

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	-	-
3	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
5	3	3	2	-	-	-	-	-	-	-	-	-	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, Bernoullis 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.

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. Apply the mechanism of friction and various frictional forces involved in mechanical systems
2. Analyze the interrelation between force, mass and acceleration of particles using Newton's second law
3. Interpret the work-energy, impulse-momentum principles to understand the geometry of particles in motion
4. Investigate the geometry of rigid bodies under the influence of external applied forces
5. Assess 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	2	-	-	-	-	-	-	-	-	-	1	2	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	2	-	-
4	2	2	2	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 2 0 2 3

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.

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. Apply electrochemical principles to determine electrode potentials and analyze the performance of electrochemical and electrolytic cells, including primary and secondary batteries.
2. Analyze different types of corrosion and influencing factors to identify and suggest suitable corrosion control techniques for various industrial environments.
3. Evaluate the structure–property relationships and processing methods of thermoplastics and thermosetting polymers to select appropriate materials for engineering applications
4. Compare the properties of engineering materials such as glass, ceramics, cements, abrasives, and refractories to justify their suitability in specialized industrial and structural applications
5. Design material-based solutions using fiber-reinforced composites and smart materials by integrating their mechanical, thermal, and responsive properties for advanced engineering functions

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	-
3	2	1	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
5	1	1	2	-	-	-	-	-	-	-	-	-	-	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, CHARECTERISTICS 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.

EXPERIMENT 1 6 Hours

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

EXPERIMENT 2 4 Hours

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

EXPERIMENT 3 4 Hours

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

EXPERIMENT 4 4 Hours

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

EXPERIMENT 5 4 Hours

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

EXPERIMENT 6 **4 Hours**

Testing of thermal stability of polymer using TGA Analyzer.

EXPERIMENT 7 **4 Hours**

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, Materals 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 **2 0 2 3**

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.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PSO1.Design, analyse and evaluate the performance of mechanical systems

Course Outcomes (COs)

1. Infer the behavior of diodes in rectifier and regulator applications, and analyze the role of special electronic devices in basic circuit design
2. Analyze and simplify Boolean expressions using Karnaugh maps to understand logic behavior and circuit efficiency
3. Illustarte the working of analog ICs in various configurations and examine their characteristics.
4. Design basic analog circuits using the 741 Op-Amp by understanding its internal block diagram
5. Develop a control and interface circuits for actuators such as DC, servo, and stepper motors using appropriate electronic devices for embedded or automation applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	-	2	2	-	-	2	-	-
2	2	3	-	-	-	2	-	-	2	2	-	-	2	-	-
3	2	-	-	-	-	2	-	-	2	2	-	-	2	-	-
4	2	2	2	-	-	2	-	-	-	-	-	-	2	-	-
5	2	2	2	-	-	2	-	-	-	-	-	-	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 **6 Hours**

ANALOG ICS

Op-Amp (IC 741) - characteristics, application of Op-Amp adder, subtractor, comparator, ADC and DAC. Timer - (555) Astable and monostable multivibrator.

UNIT IV **6 Hours**

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.

UNIT V **6 Hours**

INTERFACING ACTUATORS

Interfacing DC motor with electronic devices, Interfacing SERVO motor with electronic devices, Interfacing stepper motor with electronic devices.

EXPERIMENT 1 6 Hours

Design of regulated power supply. (5v,9v, 12v)

EXPERIMENT 2 6 Hours

BJT as switch and amplifier in Automatic Street light.

EXPERIMENT 3 6 Hours

Combinational circuit as adder, subtractor, encoder, decoder in vending machine.

EXPERIMENT 4 6 Hours

Sequential circuit as counter in water level controller.

EXPERIMENT 5 6 Hours

Application of op-Amp in measurement of temperature.

Total: 60 Hours

Reference(s)

1. David. A. Bell (2003), Laboratory Manual for Electronic Devices and Circuits, Prentice Hall, India
2. 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, 2008
4. 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 2 0 2 3

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.

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.

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.

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. Apply appropriate casting processes to produce simple metal components using moulds with cores
2. Implement the suitable welding techniques to join materials using appropriate welding equipment.
3. Analyze bulk deformation processes to recommend suitable methods based on functional and application requirements.
4. Investigate process parameters and diagnose defect causes in sheet metal forming techniques to optimize manufacturing performance.
5. Evaluate sheet metal and special forming processes by analyzing their process parameters, advantages, limitations, and suitability for different manufacturing scenarios

Articulation Matrix

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

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.

EXPERIMENT 1 3 Hours

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

EXPERIMENT 2 3 Hours

Casting of aluminium components

EXPERIMENT 3 **3 Hours**
Fabrication of simple structural shapes using manual Metal Arc Welding

EXPERIMENT 4 **3 Hours**
Fabrication of simple structural shapes using TIG and MIG welding

EXPERIMENT 5 **3 Hours**
Manufacturing of Simple sheet metal components using shearing and bending operations

EXPERIMENT 6 **3 Hours**
Drawing of cup shaped product

EXPERIMENT 7 **3 Hours**
To make a simple thermoplastic component using injection Moulding

EXPERIMENT 8 **3 Hours**
To make a simple component using compression Moulding

EXPERIMENT 9 **3 Hours**
3Extrusion of rod drawing

EXPERIMENT 10 **3 Hours**
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 Stings 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.
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.
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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply basic programming concepts like data types, arrays, and control structures to build simple programs.
2. Develop object-oriented programs using classes, objects, constructors, and destructors.
3. Design applications using inheritance, overloading, and overriding for code reusability.
4. Illustrate the different function calling methods and friend functions to manage data flow.
5. Analyze static variables and packages to organize and reuse code effectively.

Articulation Matrix

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

EXPERIMENT 1 **3 Hours**
Working with basic data types and arrays.

EXPERIMENT 2 **3 Hours**
Implementation of control statements.

EXPERIMENT 3 **3 Hours**
Implementation of looping statements.

EXPERIMENT 4 **3 Hours**
Implementation of class and objects.

EXPERIMENT 5 **3 Hours**
Working with constructor and destructor.

EXPERIMENT 6 **3 Hours**
Implementation of types of Inheritance.

EXPERIMENT 7 **3 Hours**
Working with call by value and call by reference.

EXPERIMENT 8 **3 Hours**
Implementation of friend function.

EXPERIMENT 9 **3 Hours**
Implementation of overloading.

EXPERIMENT 10 **3 Hours**
Working with basic data types, static variables and arrays.

EXPERIMENT 11 **6 Hours**
Program on Classes and objects.

EXPERIMENT 12 **6 Hours**
Working with Methods.

EXPERIMENT 13 **6 Hours**
Implementation of Inheritance.

EXPERIMENT 14 **6 Hours**
Implementation of Overloading and Overriding.

EXPERIMENT 15 **6 Hours**
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.
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 Fourier series to represent various mechanical waveforms by classifying functions as even or odd and constructing appropriate full- or half-range series
2. Analyze the wave and heat conduction problems and find solutions for membrane vibrations by applying Fourier series methods.
3. Assess the Laplace and inverse Laplace transforms to solve differential equations in engineering contexts.
4. Infer expectation and variance of Binomial and Poisson distributions based on probability rules and characteristics of random variables
5. Investigate the statistical inference and hypothesis testing to assess and ensure the quality and reliability of 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	3	-	-	-	-	-	-	-	-	-	-	1	-	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
4	2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
5	2	2	3	2	-	-	-	-	-	-	-	-	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**

PROBABILTY 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 Bhatacharyya 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.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Interpret the fundamental properties of fluids and apply fluid statics principles to measure fluid pressure using appropriate methods.
2. Demonstrate the phenomenon of fluid motion using the continuity, Bernoulli's, and momentum equations, and quantify energy losses in various piping systems.
3. Apply dimensional analysis techniques to investigate the significance of dimensionless parameters and similitude in fluid flow over bodies.
4. Analyze the performance of hydraulic pumps using velocity triangles and evaluate their efficiency under varying conditions.
5. Investigate the working principles of hydraulic turbines using velocity triangles, and assess their performance through specific speed and characteristic curves.

Articulation Matrix

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

UNIT I **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 **6 Hours**

FLUID KINEMATICS AND DYNAMICS

Concept of control volume - continuity equation, Bernoullis 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.

UNIT III **6 Hours**

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.

UNIT IV **6 Hours**

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.

UNIT V **6 Hours**

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.

EXPERIMENT 1 3 Hours

Visualize the flow using Reynolds apparatus

EXPERIMENT 2 3 Hours

Verification of Bernoullis theorem and Determine the coefficient of discharge using Venturimeter

EXPERIMENT 3 3 Hours

Determination of friction factor for a given set of pipes

EXPERIMENT 4 **3 Hours**

Determine the coefficient of discharge for a rotometer and orificemeter

EXPERIMENT 5 **3 Hours**

Determination of lift and drag force of an aerofoil.

EXPERIMENT 6 **3 Hours**

Performance test on tangential flow impulse turbine against constant head.

EXPERIMENT 7 **3 Hours**

Performance test on Francis turbine against constant head

EXPERIMENT 8 **3 Hours**

Performance test on reaction (Kaplan) turbine

EXPERIMENT 9 **3 Hours**

Performance test on centrifugal pump.

EXPERIMENT 10 **3 Hours**

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.

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

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	-	-	-	-	-	-	2	-	-	3
2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	3
3	2	3	-	-	-	-	-	-	-	-	-	2	-	-	3
4	2	3	-	-	-	-	-	-	-	-	-	2	-	-	3
5	1	2	2	3	-	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 2 0 2 3

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.

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.

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. Apply the principles of orthogonal and oblique cutting and evaluate metal cutting performance using Merchant's Circle.
2. Develop the simple cylindrical and stepped components by using lathe machines suited for specific applications.
3. Analyze milling and gear cutting processes to select suitable machines for manufacturing components based on workpiece specifications.
4. Demonstrate machining operations on basic components using suitable reciprocating and drilling machines, based on part geometry and production requirements.
5. Develop components with specified surface finish, texture, and dimensional accuracy using broaching and finishing processes.

Articulation Matrix

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

EXPERIMENT 1 3 Hours

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

EXPERIMENT 2 3 Hours

Exercise on step turning using orthogonal and oblique cutting tool.

EXPERIMENT 3 3 Hours

Exercise on grooving, thread cutting and boring using centre lathe

EXPERIMENT 4 3 Hours

Exercise on turning, drilling and tapping using capstan lathe.

EXPERIMENT 5 3 Hours

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

EXPERIMENT 6 **3 Hours**

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

EXPERIMENT 7 **3 Hours**

Machining an internal key way using Slotter machine.

EXPERIMENT 8 **3 Hours**

Exercise on drilling and tapping operation using drilling machine.

EXPERIMENT 9 **3 Hours**

Machining a metal flat using surface grinding machine.

EXPERIMENT 10 **3 Hours**

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.

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 kinematic principles to determine degrees of freedom, mechanical advantage, and inversions in basic planar mechanisms.
2. Investigate velocity and acceleration in simple and complex planar mechanisms using graphical methods to support motion analysis.
3. Analyze the motion characteristics of different follower types and cam profiles to meet specific operating conditions.
4. Compare different types of gear systems and gear trains, and compute speed ratios and transmission parameters.
5. Evaluate belt and clutch drive parameters to develop the efficient friction-drive systems for power transmission applications.

Articulation Matrix

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

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 Dukkipati, 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.

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

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Illustrate the fundamentals of machine drawing, including BIS drawing codes, limits, fits, tolerances, surface roughness, and weld symbols.
2. Analyze various machine drawing types such as assembly, production, detailed, and patent drawings to infer their functional and design purposes.
3. Assemble mechanical components such as couplings, glands, and joints by interpreting detailed engineering drawings and bill of materials
4. Apply the concept of sectional views in machine elements to interpret the suitability of part integration within assemblies
5. Develop complete assembly drawings for machine components such as screw jack, plummer block, and connecting rod by integrating standard practices in sectional and detailed representations

Articulation Matrix

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

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 Griffths, 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)

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

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

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

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

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

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

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

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 3D modeling techniques to create orthographic views from given isometric drawings for mechanical components using CAD software tools.
2. Develop 3D assembly models of mechanical components and subsystems like bearings, shafts, and couplings, incorporating dimensional tolerances and constraints.
3. Create accurate assembly models of mechanical systems including piston–connecting rods, power drives, and suspensions, ensuring geometric compatibility and assembly relationships.
4. Simulate the motion of simple mechanical mechanisms and visualize their working using animation features in 3D modeling software.
5. Build a detailed technical documentation including exploded views and part lists for complex assemblies such as an I.C. engine, adhering to industrial drafting standards.

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

EXPERIMENT 1 **6 Hours**

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

EXPERIMENT 2 **6 Hours**

Construct a three dimensional assembly model of bearing.

EXPERIMENT 3 **6 Hours**

Generate a three dimensional shaft and coupling assembly model by considering tolerance in each Component.

EXPERIMENT 4 **6 Hours**

Create a three dimensional assembly model of Piston and Connecting Rod.

EXPERIMENT 5 **6 Hours**

Build a three dimensional assembly model of power drive system.

EXPERIMENT 6 **6 Hours**

Create a three dimensional assembly model of two wheeler suspension system.

EXPERIMENT 7 **6 Hours**

Construct a three dimensional assembly model of control valve.

EXPERIMENT 8 **6 Hours**

Generate a three dimensional assembly model of Jig/fixture.

EXPERIMENT 9 **6 Hours**

Create a three dimensional assembly model of simple mechanism and animate its working using modeling software.

EXPERIMENT 10 **6 Hours**

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)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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
PSO1. Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply verbal ability skills to approach placement test tasks with clarity and confidence
2. Analyze effective written communication for professional and workplace settings, and develop confidence in writing.

Articulation Matrix

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

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

Course Outcomes (COs)

1. Apply numerical methods to solve nonlinear equations and linear systems.
2. Implement finite difference tables for forward and backward interpolation.
3. Investigate the limitations of various numerical techniques for differentiation and integration.
4. Develop numerical solutions to ordinary differential equations using appropriate numerical methods.
5. Analyze finite difference methods to simulate partial differential equations for solving complex engineering problems

Articulation Matrix

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

UNIT I **9 Hours**

APPROXIMATION

Approximation in numerical computation: Truncation and rounding errors- fixed and floating-pointarithmetic - 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, Iyangar 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 2 0 2 3

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.

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.

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 basic principles of fluid power systems and infer the effects of fluid properties and flow types in hydraulic applications.
2. Illustrate the construction and working of various hydraulic pumps and actuators, and compare their performance characteristics.
3. Develop the control strategies using pressure, direction, and flow control valves to simulate the hydraulic circuits.
4. Investigate the components of pneumatic systems and servo mechanisms for automation purposes.
5. Design and simulate the hydraulic and pneumatic circuits using PLC for engineering applications.

Articulation Matrix

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

EXPERIMENT 1 **2 Hours**

Identification of fluid power system components with its symbols.

EXPERIMENT 2 **2 Hours**

A study on pascals law with one application

EXPERIMENT 3 **3 Hours**

Simulation of single and double acting cylinder.

EXPERIMENT 4 **3 Hours**

Simulation of rotary actuator.

EXPERIMENT 5 **3 Hours**

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

EXPERIMENT 6 **3 Hours**

Construction and simulation of hydraulic circuit using intensifier and accumulator.

EXPERIMENT 7 **3 Hours**

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

EXPERIMENT 8 **3 Hours**

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

EXPERIMENT 9 **4 Hours**

Simulation of speed control circuits and sequential circuit.

EXPERIMENT 10 **4 Hours**

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.

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

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

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

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

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

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. Analyze the dynamic behavior of simple mechanisms and design flywheels for energy fluctuation control.
2. Apply force and couple polygon methods to determine the balancing mass required for rotating and reciprocating systems.
3. Infer the gyroscopic effect on ships and airplanes, and calculate the speed range of governors to assess system stability.
4. Evaluate the natural frequency of single degree of freedom systems under free and forced vibrations.
5. Investigate the single, two and three rotor system concepts to evaluate the natural frequencies of transverse and torsional vibrating systems.

Articulation Matrix

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

EXPERIMENT 1 3 Hours

Determine the moment of inertia of object by flywheel.

EXPERIMENT 2 3 Hours

Dynamic analysis of four bar mechanism using CAD software

EXPERIMENT 3 3 Hours

Exercise on Balancing of reciprocating masses in slider crank mechanism.

EXPERIMENT 4 3 Hours

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

EXPERIMENT 5 3 Hours

Determine the characteristics and effort of Porter and Proell Governors.

EXPERIMENT 6 3 Hours

Analyze the gyroscopic effect using Gyroscope and verify its laws.

EXPERIMENT 7 **3 Hours**

Determination of natural frequency of single degree of freedom system.

EXPERIMENT 8 **3 Hours**

Determine the frequency of forced vibration using electro dynamic shaker.

EXPERIMENT 9 **3 Hours**

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

EXPERIMENT 10 **3 Hours**

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 Uichker and Joesph 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.

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

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

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

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

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

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

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 **6 Hours**

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

UNIT III **6 Hours**

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.

UNIT IV **6 Hours**

DEFLECTION OF BEAMS AND COLUMNS

Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay's method. Types of Columns, Equivalent length, Euler and Rankine's formulae, Slenderness ratio

UNIT V **6 Hours**

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

EXPERIMENT 1 — 3 Hours

Find the hardness of the material using Rockwell hardness tester

EXPERIMENT 2 — 3 Hours

Calculate the hardness of the material using Brinell hardness tester

EXPERIMENT 3 — 3 Hours

Calculate the hardness of the material using micro Vickers hardness tester

EXPERIMENT 4 **3 Hours**

Plot stress-strain curve by observing the tensile behaviour of the given specimen

EXPERIMENT 5 **3 Hours**

Study the deflection of a simply supported beam and compare the experimental values of deflection with the theoretical values.

EXPERIMENT 6 **3 Hours**

Determine the compressive strength of the materials

EXPERIMENT 7 **3 Hours**

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

EXPERIMENT 8 **3 Hours**

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

EXPERIMENT 9 **3 Hours**

Determination of spring constant through load vs deflection curve

EXPERIMENT 10 **3 Hours**

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.
PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO3. Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the thermodynamic principles to evaluate the performance of single-cylinder and multi-cylinder internal combustion engines.
2. Analyze the thermal performance of modified Brayton and Rankine cycles to enhance efficiency and work ratio.
3. Assess steam nozzle efficiency and turbine stage behavior through impulse and reaction principles, critical pressure ratios and velocity diagrams.
4. Investigate the reciprocating and rotary compressors with and without clearance volume, to select the suitable compressor for HVAC application
5. Design vapor compression systems with subcooling and superheating techniques for refrigeration and air conditioning applications.

Articulation Matrix

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

UNIT I **6 Hours**

INTERNAL COMBUSTION ENGINES

Internal combustion engines - 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 RSHF, GSHF, 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.

EXPERIMENT 1 3 Hours

Experimental study on port timing and valve timing diagram of IC engines.

EXPERIMENT 2 3 Hours

Experimental study on performance test of 4-Stroke diesel engine

EXPERIMENT 3 **3 Hours**
Experimental study on heat balance test of 4-Stroke diesel engine

EXPERIMENT 4 **3 Hours**
Experimental study on performance test of 4-Stroke Petrol engine

EXPERIMENT 5 **3 Hours**
Morse test on multi-cylinder petrol engine

EXPERIMENT 6 **3 Hours**
Study of steam turbines and steam nozzles

EXPERIMENT 7 **3 Hours**
Experimental study on performance of two stage reciprocating air compressor

EXPERIMENT 8 **3 Hours**
Experimental study on rotary compressors

EXPERIMENT 9 **3 Hours**
Experimental study on determination of Coefficient of Performance of refrigeration system

EXPERIMENT 10 **3 Hours**
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 **2 0 2 3**

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. Apply the architecture and instruction set of 8085 and 8051 to develop simple assembly language programs.
2. Analyze the timing diagrams and addressing modes of microprocessor and microcontroller to interpret their operations accurately.
3. Design and develop interfacing solutions for memory and I/O devices using 8085 microprocessor.
4. Develop programs to interface ADC, DAC, sensors, and actuators using 8051 microcontroller for real-time applications.
5. Integrate various microprocessor-based system configurations and demonstrate applications such as LED displays and traffic light control.

Articulation Matrix

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

EXPERIMENT 1 **4 Hours**

Programs for 8/16 bit Arithmetic operations (Addition / Subtraction) (Using 8085).

EXPERIMENT 2 **2 Hours**

Programs for 8 bit Arithmetic operations (Multiplication / Division) (Using 8085).

EXPERIMENT 3 **4 Hours**

Program for finding Ascending order and Descending order (Using 8085).

EXPERIMENT 4 **4 Hours**

Program for finding Maximum and Minimum number (Using 8085).

EXPERIMENT 5 **4 Hours**

Interfacing and Programming of 8279

EXPERIMENT 6 **2 Hours**

Interfacing and Programming of 8255

EXPERIMENT 7 **2 Hours**

Interfacing of Analog to Digital Converter (ADC) using 8085 microprocessor.

EXPERIMENT 8 **2 Hours**

Interfacing of Digital to Analog Converter (DAC) using 8085 microprocessor.

EXPERIMENT 9 **2 Hours**

Programming Arithmetic operation (Addition / Subtraction) using 8051 microcontroller.

EXPERIMENT 10 **4 Hours**

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)

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

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

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

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

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

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

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. Apply design concepts to create detailed 2D orthographic and sectional views from 3D part and assembly models, incorporating dimensional and geometric tolerances.
2. Design complex surface models to develop the automotive components and consumer products such as PET bottles.
3. Develop the surface model using sheet metal for automotive and HVAC systems.
4. Analyze fluid power systems to predict motion and collision responses using virtual simulation tools
5. Demonstrate Product Lifecycle Management (PLM) concepts by applying comprehensive technical documentation and 3D assembly models

Articulation Matrix

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

EXPERIMENT 1 **6 Hours**

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

EXPERIMENT 2 **6 Hours**

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

EXPERIMENT 3 **6 Hours**

Generate a three dimensional surface models of automotive components

EXPERIMENT 4 **6 Hours**

Create a three dimensional surface models of pet bottles for specific capacities.

EXPERIMENT 5 **6 Hours**

Build sheet metal models of automotive components.

EXPERIMENT 6 **6 Hours**

Build sheet metal models of Air Conditioning Systems.

EXPERIMENT 7 **6 Hours**

Create simulation of slider crank mechanisms and analyze its collisions.

EXPERIMENT 8 **6 Hours**

Create simulation of hydraulic /pneumatic systems analyze its collisions

EXPERIMENT 9 **6 Hours**

Create a three dimensional assembly model and generate the detailed document with PLM concept.

EXPERIMENT 10 **6 Hours**

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.
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.
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

Course Outcomes (COs)

1. Apply the interdisciplinary nature of environmental studies to understand and address the exploitation of natural resources
2. Analyze different types of ecosystems and biodiversity, their ecological values, and the role of professionals in preventing environmental degradation
3. Develop remedial actions for current environmental challenges related to pollution and its effective management
4. Design suitable strategies for the sustainable management of key components in environmental science
5. Investigate 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	3	-	-	-	-	-	-	2	-	-	-	2	-	2	-
2	2	3	-	-	-	-	-	2	-	-	-	2	-	2	-
3	2	2	2	-	-	-	-	2	-	-	-	2	-	2	-
4	1	2	2	-	-	-	2	2	-	-	-	2	-	2	-
5	2	2	2	2	-	-	2	2	-	-	-	2	-	2	-

UNIT I **6 Hours**

NATURAL RESOURCES

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

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

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

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

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

Course Outcomes (COs)

1. Apply listening, reading, speaking, and writing skills in Business English to function effectively at the level of independent users.
2. Design strategies and study plans to develop the necessary skills to appear confidently for the Business English Certificate (BEC) Vantage level examination conducted by Cambridge Assessment English.

Articulation Matrix

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

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 2 0 2 3

Course Objectives

- To study the concepts of measurement and characteristics of instruments.
- To learn the methods for performing linear and angular measurements accurately.
- To provide knowledge on measurement of thread, gear and geometric tolerances using suitable instruments.
- To study the use of laser and advances in metrology for measuring the 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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost

Course Outcomes (COs)

1. Apply principles of measurement systems, standards, and instrument characteristics to achieve precise engineering applications in metrology.
2. Demonstrate the operation of linear and angular measuring instruments to meet specific inspection requirements in metrology.
3. Contrast techniques for measuring screw threads, gears, roundness, and form deviations to select suitable methods for evaluating part conformity.
4. Investigate the role of interferometers, coordinate measuring machines, and surface roughness systems in evaluating the geometric accuracy of components.
5. Analyze methods for measuring force, torque, power, pressure, and temperature to ensure accurate data collection.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	2	1	-	-	-	2	-
2	3	-	-	-	2	-	-	-	2	1	-	-	-	2	-
3	2	3	-	-	2	-	-	-	2	1	-	-	-	2	-
4	3	-	-	-	2	-	-	-	2	1	-	-	-	2	-
5	2	3	-	-	2	-	-	-	2	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, Bridgeman gauge, Mcleod gauge, Pirani gauge - Temperature Measurement: bimetallic strip, thermocouples, metal resistance thermometer, pyrometers.

EXPERIMENT 1 3 Hours

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

EXPERIMENT 2 3 Hours

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

EXPERIMENT 3 3 Hours

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

EXPERIMENT 4 3 Hours

Measurement of screw thread specifications by direct and indirect method.

EXPERIMENT 5 3 Hours

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

EXPERIMENT 6 3 Hours

Differentiate the work piece by its surface roughness value.

EXPERIMENT 7 3 Hours

Measurement of Straightness of a given job by using Autocollimator and Interferometer.

EXPERIMENT 8 **3 Hours**

Machine tool alignment test on Lathe / Milling machine / Drilling machine.

EXPERIMENT 9 **3 Hours**

Measurement of torque in a cantilever beam.

EXPERIMENT 10 **3 Hours**

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 understand the design procedure of machine elements subjected to simple and variable loads.
- To study the design steps of shafts and couplings.
- To provide knowledge on the design of bolted and welded joints
- To impart knowledge on the design of helical, leaf and torsional springs subjected to constant and variable loads.
- To familiarize 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.

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. Analyze methods for measuring force, torque, power, pressure, and temperature to ensure accurate data collection.
2. Apply failure theories and fatigue design process to study the influence of steady, impact, and variable loading on machine elements.
3. Design shaft and coupling based on strength, stiffness, and critical speed to recommend it for automotive and other power transmission applications.
4. Interpret the behavior of bolted and welded joints under static and eccentric loading to ensure safety and reliability in mechanical structures
5. Implement constant and variable load conditions in the design of helical, leaf, and torsional springs to ensure their safety and functional reliability.
6. Analyze the given load, speed and application constraints to design the appropriate journal and rolling contact bearings for engineering applications such as motor and pump.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	-	-	1	-	1	2	-	-
2	2	2	3	-	-	2	-	-	-	1	-	1	2	-	-
3	2	2	-	-	-	2	-	-	-	1	-	1	2	-	-
4	2	2	3	-	-	2	-	-	-	1	-	1	2	-	-
5	2	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 2 0 2 3

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

Course Outcomes (COs)

1. Apply machinery elements in CNC machines for industrial applications, demonstrating modern control strategies, including DNC and adaptive control.
2. Analyze the constructional features and motion control elements of CNC machines to evaluate their role in efficient system retrofitting and maintenance.
3. Illustrate the data flow of using modern communication protocols by analyzing the drive systems, sensors, PLC-based control architecture, and communication interfaces used in CNC systems
4. Demonstrate CNC part program using G & M codes for standard turning operations with FANUC and Siemens controllers, and simulate tool path movements using CAM software.
5. Develop CNC machining programs for multi-pass operations using canned cycles by collaborating modern CNC simulation tools, and communicating outcomes through experimental reports.

Articulation Matrix

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

UNIT I **6 Hours**

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

UNIT II **6 Hours**

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.

UNIT III **6 Hours**

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.

UNIT IV **6 Hours**

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

UNIT V **6 Hours**

PROGRAMMING OF CNC TURNING CENTRE

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

EXPERIMENT 1 **5 Hours**

Simulation and NC part program generation on facing and step turning

EXPERIMENT 2 **5 Hours**

Simulation and NC part program generation on taper turning and profile turning

EXPERIMENT 3 **5 Hours**

Simulation and NC part program generation on grooving cycle and thread cutting

EXPERIMENT 4 **5 Hours**

Simulation and NC part program generation on drilling and boring cycle

EXPERIMENT 5 **10 Hours**

To make one of the following product: Push fit assembly/simple cylinder piston assembly/milling tool holder/needle valve spool

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.

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

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

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

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

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

EXPERIMENT 1 **3 Hours**

Determination of thermal conductivity for one dimensional steady state conduction

EXPERIMENT 2 **3 Hours**

Determination of heat transfer co-efficient by unsteady heat transfer

EXPERIMENT 3 **3 Hours**

Determination of heat transfer co-efficient by natural convection

EXPERIMENT 4 **3 Hours**

Determination of heat transfer co-efficient by forced convection

EXPERIMENT 5 **3 Hours**

Determination of Stefan-Boltzmann constant

EXPERIMENT 6 **3 Hours**

Determination of emissivity using emissivity apparatus

EXPERIMENT 7 **3 Hours**

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

EXPERIMENT 8 **3 Hours**

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

EXPERIMENT 9 **3 Hours**

Experimentation on mass transfer

EXPERIMENT 10 **3 Hours**

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/

18GE501 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)

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

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

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

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

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

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

Course Outcomes (COs)

1. Demonstrate various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyze the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Develop 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	3	-	-	-	-	-	-	-	2	2	-	-	-	2	-
2	2	3	-	-	-	-	-	-	2	2	-	-	-	2	-
3	3	-	-	-	-	-	-	-	2	2	-	-	-	2	-
4	2	-	3	-	-	-	-	-	2	2	-	-	-	2	-

UNIT I **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.

UNIT II **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.

UNIT III **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.

UNIT IV **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.

UNIT V **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.

UNIT VI **2 Hours**

TIME AND WORK

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

UNIT VII **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.

UNIT VIII **2 Hours**

CODING AND DECODING

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

UNIT IX **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.

UNIT X **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.

UNIT XI **2 Hours**

DIRECTION

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

UNIT XII **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 Publicati

21HS002 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

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

UNIT I I **6 Hours**

EMBRACING THE COMMON ETIQUETTE

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

UNIT I II **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

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

UNIT I V **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

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

UNIT V **6 Hours**

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

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

Total: 30 Hours

Reference(s)

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

21ME602 MECHATRONICS **2 0 2 3**

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.

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.

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 measurement principles to select and integrate suitable sensors into basic mechatronic systems.
2. Design motion control systems by selecting and integrating suitable actuators to meet specific task requirements.
3. Analyze the behavior of open-loop and closed-loop control systems by applying transfer function concepts and modeling techniques to mechanical and electrical systems.
4. Develop the instruction sets and programming logic to perform arithmetic, logic, and data transfer operations for solving embedded system.
5. Design PLC programs for industrial automation, by integrating timers, counters, shift registers, and control instructions including master and jump functions.

Articulation Matrix

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

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.

EXPERIMENT 1 3 Hours

Design and implement a smart parking system using an ultrasonic sensor interfaced with a microcontroller

EXPERIMENT 2 3 Hours

Use an encoder in the microcontroller and ensure the correctness in the position by DC motor of the mono panel mount dual axis control solar system.

EXPERIMENT 3 3 Hours

Develop a program to microcontroller control the position of a servo motor in an automated door locking mechanism.

EXPERIMENT 4 **6 Hours**

Create a mathematical model of the DC motor in the solar tracking control system.

EXPERIMENT 5 **3 Hours**

Develop a program for temperature measurement, interfaced with a microcontroller, for acquiring the Heat pump operations.

EXPERIMENT 6 **6 Hours**

Implement the stepper motor control and develop the program for simple rectangular 3mm acrylic board cutting operation by a laser machine.

EXPERIMENT 7 **6 Hours**

Develop the ladder diagram for PLC operations in the punching machine operations.

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.

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. Apply numerical methods to formulate simple finite element models for structural analysis.
2. Illustrate bar, beam, and truss behavior through one-dimensional finite element analysis to support structural design decisions.
3. Analyze plane stress, plane strain, and axisymmetric conditions for structural applications
4. Investigate temperature distribution in 1D and 2D heat transfer using finite element methods.
5. Develop higher-order and isoparametric finite element models using numerical methods.

Articulation Matrix

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

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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 2 0 2 3

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

Course Outcomes (COs)

1. Apply various automated material handling systems and inspection methods to recommend appropriate solutions for specific manufacturing applications
2. Analyse economics and testing procedures to assess the performance and operational feasibility of CNC machines.
3. Develop CNC part programs for prismatic components using standard controller formats for machining centers.
4. Demonstrate the CAM software tools to generate NC codes from CAD models for automated manufacturing processes.
5. Create a macro and parametric programming strategies to automate CNC operations for customized manufacturing tasks.

Articulation Matrix

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

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.

EXPERIMENT 1 5 Hours

Simulation and NC part program generation on linear and circular interpolation for a Pulsar disc brake.

EXPERIMENT 2 5 Hours

Simulation and NC part program generation on contour milling of a centrifugal pump casing.

EXPERIMENT 3 5 Hours

Simulation and NC part program generation on drilling and peck drilling of gear pump flange.

EXPERIMENT 4 **5 Hours**

Simulation and NC part program generation on Mirror imaging in CNC Milling of a SI engine piston head.

EXPERIMENT 5 **13 Hours**

Simulation and NC part program generation for Injection mould die assembly for BIT logo keychain.

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 axisymetric 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.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
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. Investigate the temperature distribution and thermal stresses of thermal systems using FEA software.
2. Apply the finite element software tools to analyze stresses in bar, beam, and truss elements under static loading conditions.
3. Analyse complex geometries and load conditions for the determination of stresses and strains in engineering applications
4. Interpret plane stress, plane strain and axisymetric conditions to engineering problems and analyze using FEA software.
5. Simulate the torsional behavior of shafts, buckling of columns, and dynamic response of simple structures using FEA software.
6. Investigate the temperature distribution and thermal stresses of thermal systems 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	1			2	1	-	-	2	-	-
2	2	2	-	-	2	1			2	1	-	-	2	-	-
3	2	-	-	-	2	1			2	1	-	1	2	-	-
4	2	2	-	-	2	1			2	1	-	1	2	-	-
5	2	2	2	-	2	1			2	1	-	1	-	2	-

EXPERIMENT 1 **6 Hours**

Predicting Failure Points and Load Capacity of Stepped Crankshafts for Enhanced two wheeler Engine Performance.

EXPERIMENT 2 **6 Hours**

Structural Analysis of Beams and Trusses for Enhanced Performance and Reduced building Construction Costs.

EXPERIMENT 3 **6 Hours**

Structural Analysis of Lightweight Steel Structures with Holes for Improved Efficiency and Structural Integrity for automobile chassis application.

EXPERIMENT 4 **6 Hours**

Predicting Stress Distribution and Minimizing Material Waste in Compressed Composite Structures for car dashboard.

EXPERIMENT 5 **6 Hours**

Light weighting Cylindrical Pressure Components for Enhanced Efficiency and Reduced Operating Costs in underwater vehicle hull.

EXPERIMENT 6 **6 Hours**

Optimizing Shaft Design in heavy vehicle application for Enhanced Torque Transmission and Reduced Deflection.

EXPERIMENT 7 **6 Hours**

Developing Design Guidelines to Prevent Buckling Failures in Structural Element of a bridge.

EXPERIMENT 8 **6 Hours**

Understanding Vibration Characteristics of Beams for Improved Design and Performance in power transmission shaft of a bus.

EXPERIMENT 9 **6 Hours**

Minimizing Thermal Waste in Electronic Devices through Improved Fin Geometry

EXPERIMENT 10 **6 Hours**

Optimizing Building Insulation Strategies for Improved Energy Efficiency in Diverse Thermal Environments.

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)

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

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

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

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

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

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

Course Outcomes (COs)

1. Assess the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Analyze the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Demonstrate the objects involving cubes and cuboids in determining the number of sides colored.
4. Develop various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

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Articulation Matrix

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

UNIT I **2 Hours**

PERMUTATION AND COMBINATION

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

UNIT II **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.

UNIT III **2 Hours**

SYLLOGISM AND VENN DIAGRAM

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

UNIT IV **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.

UNIT V **2 Hours**

MIXTURES AND ALLIGATION

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

UNIT VI **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.

UNIT VII **2 Hours**

DATA INTERPRETATION

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

UNIT VII **2 Hours**

PROGRESSION AND LOGICAL REASONING

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

UNIT IX **2 Hours**

PROBLEM ON AGES

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

UNIT X **2 Hours**

ANALYTICAL REASONING

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

UNIT XI **2 Hours**

BLOOD RELATION

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

UNIT XII **2 Hours**

VISUAL REASONING

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

UNIT XIII **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.

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

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

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

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

Course Outcomes (COs)

1. Apply the principles of linear programming to formulate and solve engineering problems using graphical and simplex methods.
2. Analyze transportation and assignment problems to evaluate and compare allocation strategies using MODI and Hungarian methods.
3. Develop project networks for the given problems to determine critical paths and project durations using CPM and PERT techniques.
4. Investigate single and multi-server queuing models to interpret and assess system performance in service systems.
5. Develop sequencing strategies and replacement policies using analytical models to optimize industrial operations.

Articulation Matrix

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

UNIT I **9 Hours**

LINEAR PROGRAMMING

Operations Research - Introduction, Scope, Objectives, Phases, and its limitations. Linear Programming Problem(LPP) Formulation, Graphical method, Simplex method. Artificial variable techniques - Big-M method and two-phase method.

UNIT II **9 Hours**

TRANSPORTATION AND ASSIGNMENT MODEL

Transportation - Introduction, Initial basic feasible solutions - Northwest corner rule, Least cost method, and Vogel's approximation method. Optimality test using MODI method. Assignment - Introduction and Hungarian method for optimal solution. Travelling salesman problem.

UNIT III **9 Hours**

NETWORK MODELS AND PROJECT MANAGEMENT

Network models - Introduction, Rules for construction and errors. Shortest route - Dijkstra's algorithm, Minimal spanning tree - Kruskal's algorithm, Maximum flow models. Project management - CPM and PERT networks.

UNIT IV **9 Hours**

QUEUING MODELS

Queuing model - Introduction , Elements, Kendall's Notation, Parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.

UNIT V **9 Hours**

SEQUENCING AND REPLACEMENT MODEL

Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy.

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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 **2 0 2 3**

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

.**Course Outcomes (COs)**

1. Apply robotic anatomy and joint configurations to analyze the structure and functions of industrial manipulators.
2. Demonstrate the principles of actuation and gripping for configuring drive systems and end effectors in industrial robotic applications.
3. Analyze sensing and machine vision solutions to effectively integrate robotic systems into industrial applications
4. Design models of robotic motion based on forward and inverse kinematics principles and construct suitable robot programs
5. Develop robotic implementations across various industries to enhance productivity and automation efficiency.

Articulation Matrix

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

EXPERIMENT 1 4 Hours

Develop a geometric model of a simple robot arm with a working simulation.

EXPERIMENT 2 4 Hours

Demonstrate the various components in and its function in Robot

EXPERIMENT 3 4 Hours

Demonstrate how load cells operate and caliberate fr accurate load measurements.

EXPERIMENT 4 **4 Hours**

Develop a robot for pick and place applications in cargo industries and simulate it.

EXPERIMENT 5 **4 Hours**

Develop a robot for the automotive car-making industry and simulate it.

EXPERIMENT 6 **4 Hours**

Develop a robot for medical industries to handle class materials.

EXPERIMENT 7 **4 Hours**

Develop a robot for E-comerce applications

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/1121031

21ME707 PROJECT WORK I **0 0 6 3**

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.
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. Apply technical knowledge to a real-world problem by identifying requirements and using appropriate tools or techniques to address it
2. Develop innovative technical strategies and methodologies to address and solve complex engineering problems
3. Apply relevant tools, algorithms, and techniques to design and implement effective solutions for the given project.
4. Evaluate the performance of the developed solution / prototype through systematic testing, validation, and cost-effectiveness analysis to verify its compliance with specified project requirements.
5. Prepare comprehensive technical documentation and deliver effective oral presentations to communicate project outcomes

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

21ME801 PROJECT WORK II **0 0 18 9**

Course Objectives

- To develop skills to formulate a technical project.
- To develop skills to formulate a technical project.
- To teach use of new tools, algorithms and techniques required to carry out the projects.
- To give guidance on the various procedures for validation of the product and analyse the cost effectiveness.
- To provide guidelines to prepare technical report of the project.

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

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

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

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

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

PSO1. 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. Apply technical knowledge to a real-world problem by identifying requirements and using appropriate tools or techniques to address it
2. Develop innovative technical strategies and methodologies to address and solve complex engineering problems
3. Apply relevant tools, algorithms, and techniques to design and implement effective solutions for the given project.
4. Evaluate the performance of the developed solution / prototype through systematic testing, validation, and cost-effectiveness analysis to verify its compliance with specified project requirements.
5. Prepare comprehensive technical documentation and deliver effective oral presentations to communicate project outcomes

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

18HS201 COMMUNICATIVE ENGLISH II 1 0 2 2

Course Objectives

- Read and understand ideas of complex text on both concrete and abstract topics
- Listen and understand technical discussions in his/her field of specialisation
- Produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options
- Interact with a degree of fluency and spontaneity that makes regular interaction without strain

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply appropriate grammar and business-related vocabulary to understand and produce written communication at the BEC Vantage level.
2. Analyze the general meaning of non-routine business letters and reports on both predictable and unpredictable topics.
3. Develop simple factual reports and compose factual non-routine letters in a business context.
4. Illustrate questioning skills to get correct information, understand answers, and share or record messages clearly at work.
5. Design simple, prepared presentations on familiar business-related topics by applying basic opinions and limited arguments.

Articulation Matrix

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

UNIT I **9 Hours**

GRAMMAR3

Tenses - Future continuous, Future perfect, Future perfect continuous, Past perfect, Past perfect continuous - Adjectives and adverbs - Mixed conditionals - Modals - can't have, needn't have - Modals of deduction and speculation - Narrative tenses - Passives - Phrasal verbs, extended - Relative clauses - Reported speech - Will and going to, for prediction - Wish - Would expressing habits, in the past.

UNIT II **9 Hours**

READING

Scanning and reading for gist - Understanding text structure - Reading for gist and specific information - Vocabulary and structure - Understanding sentence structure and error identification

UNIT III **9 Hours**

WRITING

A message, memo or email, Giving instructions, explaining a development, asking for comments, requesting information, agreeing to requests - Business correspondence: explaining, apologising, reassuring, complaining, short report: describing, summarising - proposal: describing, summarising, recommending, persuading.

UNIT IV **9 Hours**

LISTENING

Listening for and noting specific information - Listening to identify topic, context, Function - Following the main points and retrieving specific information from the text.

UNIT V **9 Hours**

SPEAKING

Giving personal information: Talking about present circumstances, past experiences and future plans, expressing opinions, speculating - Organising a larger unit of discourse: Giving information and expressing and justifying opinions - Turn-taking: negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing/disagreeing, suggesting, speculating, comparing and contrasting, and decision making. 1.A Horse and Two Goats - R K Narayan 2. My Lord the Baby - Rabindranath Tagore 3. Twist in the Tale - Jeffery Archer.4.The Third and Final Continent - Jhumpa Lahiri 5.The Gift of the Magi - O Henry

Total: 45 Hours

Reference(s)

1. Guy Brook-Hart, "BEC Vantage: Business Benchmark Upper-Intermediate- Student's Books" 1st Edition, Cambridge University Press, New Delhi, 2006.
2. Ian Wood, Paul Sanderson, Anne Williams with Marjorie Rosenberg, "Pass Cambridge BEC Vantage- Student's Book" 2nd Edition, Cengage Learning, New Delhi, 2014
3. Michael Handford, Martin Lisboa, Almut Koester, Angela Pitt, "Business Advantage - Student's Book Upper-Intermediate" Cambridge University Press, New Delhi, 2014.
4. Cambridge Examinations Publishing, "Cambridge BEC VANTAGE - Self-study Edition", Cambridge University Press, UK, 2005.

18HSH01 HINDI **1 0 2 2**

Course Objectives

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Demonstrate correct pronunciation of Hindi vowels and consonants and classify them based on sound types (plosives, fricatives, nasals)
2. Apply rules of gender in noun usage and analyze differences between masculine and feminine forms in given texts.
3. Construct grammatically correct sentences using various pronouns and tenses; evaluate and correct sentence structures.
4. Assess classified vocabulary in real-life contexts and analyze the relationships among thematic vocabulary groups
5. Develop short dialogues and spoken expressions for real-life situations; evaluate clarity and appropriateness in spoken communication.

Articulation Matrix

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

UNIT I **9 Hours**

VOWELS AND CONSONANTS

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

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.

18HSG01 GERMAN 1 0 2 2

Course Objectives

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Analyze individual German phonemes by carefully listening to identify and differentiate distinct sounds accurately.
2. Apply basic German sounds and vocabulary to develop accurate pronunciation and speaking skills.
3. Develop reading comprehension by understanding short passages on familiar topics in German.
4. Design simple written texts using basic sentence structures effectively in German.
5. Illustrate the fundamental grammar and appropriate vocabulary to complete a variety of language tasks accurately.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

UNIT II **9 Hours**

LANGUAGE AND ITS COMMON USE

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

UNIT III **9 Hours**

TECHNICAL DEUTSCHE

Regular &Irregular verbs -Personal pronouns-family-Introduction to types of sentences

UNIT IV **9 Hours**

INTERROGATION

Question words -Types of Questions -Nominative case-Verb Conjugation -country -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 & Distributers Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributers Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber Munichen, 2007.

18HSJ01 JAPANESE **1 0 2 2**

Course Objectives

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3.Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Course Outcomes (COs)

1. Apply knowledge of the Japanese alphabet by recognizing and writing basic characters accurately.
2. Develop speaking skills by using basic sounds of the Japanese language in everyday contexts.
3. Formulate the appropriate vocabulary to engage in simple conversations in Japanese.
4. Design grammatically correct sentences by applying essential grammar rules in both written and spoken Japanese.
5. Analyze spoken Japanese conversations to comprehend contextual meaning, recognize key expressions, and respond appropriately in real-life communication scenarios.

Articulation Matrix

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

UNIT I **9 Hours**

SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS

Introduction to Japanese Japanese script - Pronunciation of Japanese (Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

UNIT II **9 Hours**

TIME EXPRESSION / VERBS - PAST

Introduction to time -Introduction of verbs -Listening to specific information

UNIT III **9 Hours**

ADJECTIVES

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation. Listening to Japanese Alphabet Pronunciation -Simple Conversation

UNIT IV **9 Hours**

CONJUGATION OF II ADJECTIVE

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

UNIT V **9 Hours**

CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

Total: 45 Hours

Reference(s)

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

18HSC01 CHINESE **1 0 2 2**

Course Objectives

- To help students appear for HSK Level 1 Exam
- To help students acquire the basics of Chinese language
- To teach the students how to converse in Chinese in various situations

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Analyze individual sounds of Chinese by listening attentively to recognize and differentiate phonetic elements.
2. Apply basic sounds and vocabulary in spoken communication to build foundational speaking skills.
3. Develop reading comprehension skills by interpreting and analyzing short passages on familiar topics to extract main ideas and relevant details.
4. Design simple written texts by effectively using basic sentence structures to clearly convey ideas.
5. Interpret the basic grammar and appropriate vocabulary to complete language tasks accurately and meaningfully.

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

UNIT I **9 Hours**

Hello | 1. Initials and Finals of Chinese | b,p,m,f,d,,n,l,g,k,h,j,q,x | 2. Tones Four | 3. Chinese Syllables | 4. Tone S

UNIT II **9 Hours**

Thank you | Initials and Finals of Chinese | The Neutral Tone | Rules of Tone Marking and Abbreviation

UNIT III **9 Hours**

1. What""s your name - In the school; -In the classroom; -In the school | The Interrogative Pronoun | 2 The Sentence | 3 Interrogative Sentences with

UNIT IV **9 Hours**

She is my Chinese teacher | In the library | The Interrogative Pronouns | The Structural Particle | The interrogative Particle

UNIT V **9 Hours**

Her daughter is 20 years old this year | 1.The Interrogative Pronoun | 2. Numbers below 100 |
3.Indicating a Change | The Interrogative Phrase

Total: 45 Hours

18HSF01 FRENCH 1 0 2 2

Course Objectives

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply knowledge of the French alphabet and basic vocabulary to enhance familiarity with foundational language elements.
2. Analyze individual French sounds by listening carefully to distinguish and identify phonetic components.
3. Create the basic French sounds and vocabulary in spoken interactions to develop oral proficiency.
4. Develop reading comprehension skills by engaging with short passages on familiar topics.
5. Design accurate responses in French by applying grammar rules and appropriate vocabulary while completing language tasks.

Articulation Matrix

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

UNIT I **9 Hours**

ENTRER EN CONTACT

La langue franÃƒÂ§aise, alphabets, les numÃƒÂ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

UNIT II **9 Hours**

PARTAGER SON LIEU DE VIE

Les francais et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Etre / ER, IR, RE Regulier et Irregulier) Adjectifs les propositions de lieu. Communication Chercher un logement, decrire son voisin, s informer sur un logement - Lexique L habitat, les pieces, l equipement, la description physique

9 Hours

UNIT III

VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES

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

UNIT IV **9 Hours**

COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film Lexique Les sorties, la famille, l art, les vetements et les accessoires

UNIT V **9 Hours**

GOUTER A LA CAMPAGNE

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, l argent

Total: 45 Hours

Reference(s)

1. Grammaire Progressive du Francais, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette
4. Reussir le DELF A1 Bruno Girardeau
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001

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)

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

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

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

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

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

PSO1.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 the principles and interfaces of engineering design to construct a Product Design Specification (PDS) for a defined engineering problem.
2. Analyze structured ideation techniques such as brainstorming and morphological analysis to generate and evaluate creative design concepts using decision matrices.
3. Demonstrate the ability to integrate decision-making models with design for manufacturing, assembly, and environment in the engineering design process.
4. Design cost-effective manufacturing plans using QFD, value engineering, safety factors, and ISO quality concepts for optimized material selection and production.
5. Develop professional design reports and presentation techniques while recognizing the significance of intellectual property rights and patenting processes in engineering design.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES AND PROBLEM IDENTIFICATION

Engineering design- introduction and definition, Considerations of a good design, Engineering design interfaces, Principles of engineering design, Problem identification, Design process, Product Design Specification (PDS) criteria, Content of a PDS, Codes of ethics, Solving ethical conflicts.

UNIT II **9 Hours**

CONCEPT GENERATION AND SELECTION

Identifying customer needs, Benchmarking, Societal considerations in engineering, Creativity and problem solving, creativity methods - Brainstorming, Morphological analysis, Concept selection - Subjective decision-making, Criteria ranking, Criteria weighting, Datum method, Computer aided decision making.

UNIT III **9 Hours**

DESIGN PROCESS

Detailed description of design process, Design Drawings, Computer Aided Engineering, Designing of standards, Concurrent Engineering, Human Factors in Design, Design for manufacturing (DFM), Design for Assembly (DFA), Industrial design, Design for environment, engineering design principles.

UNIT IV **9 Hours**

PLANNING FOR MANUFACTURE

Quality function deployment (QFD), Quality Assurance, Design review, Value analysis/engineering, Factor of safety, Materials selection, break even analysis - problem, cost evaluation, Elements of cost, ISO concepts, Classification of Manufacturing Process.

UNIT V **9 Hours**

REPORT PREPARATION AND INTELLECTUAL PROPERTY RIGHTS

Presentation Techniques - Introduction, Concept sketches, Scheme drawing, Design Validation, Design report. Intellectual Property Rights - Introduction, Patent, Trademark, copyright, Patentability, Non patentable, patenting process, forms for filing patents.

Total: 45 Hours

Text Book(s)

1. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, 2020.
2. George E Dieter, Engineering Design, Tata McGraw Hill publishing Company Pvt Ltd, New Delhi, 2008
3. Danlel E. Whitney, Mechanical Assembles: Design Manufacture and Role in Product Development, Oxford University, Press, 2008
4. K. Otto, Product Design, Pearson Publications, 2005.
5. Richard Birmingham, Graham Cleland, Robert Driver and David Maffin, Understanding Engineering Design, Prentice Hall of India, 1997
6. Karl T. Ulrich and Steven D. Eppinger Product Design and Development McGraw Hill Edition 7th edition 2020

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 expose the characteristics and different fabrication techniques on polymer and metal matrix composites.
- To impart knowledge on ceramic matrix composites.
- To provide knowledge on the micro mechanism of composites.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Illustarte the need, characteristics, and constituents of composite materials including types of reinforcements, forms, and matrix materials.
2. Apply suitable processing techniques for polymer matrix composites to meet functional and industrial requirements.
3. Assess the characteristics, processing methods, and applications of metal matrix composites using the rule of mixtures and reinforcement effects.
4. Develop the ceramic matrix composites using advanced processing techniques for high-temperature and aerospace applications.
5. Analyze laminated composite structures considering mechanical behavior, failure theories, and structural performance.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO COMPOSITES

Fundamentals of composites, characteristics, need for composites, Enhancement of properties, Reinforcements - glass fibers, boron fibers, carbon fibers, organic fibers, aramid fibers, ceramic fibers, oxide and nonoxide fibers, Forms of reinforcements - Roving, Woven fabrics, non-woven, random mats, whiskers, Matrix materials - Polymers - Thermosetting resins, thermoplastic resins, Metals, Ceramic materials

UNIT II **9 Hours**

POLYMER MATRIX COMPOSITE

Processing of polymer matrix composites- hand lay-up, Spray lay-up processes, Compression molding-SMC Reinforced reaction injection molding, Resin transfer molding, Pultrusion, Filament winding, Applications of polymer matrix composites.

UNIT III **9 Hours**

METAL MATRIX COMPOSITES

Characteristics of MMCs, Various types of Metal matrix composites, Advantages and limitations of MMCs, Effect of reinforcements on properties-Volume fraction - Rule of mixtures, Processing of MMCs - Liquid state processing- stir casting, squeeze casting, infiltration, solid state processing - Powder metallurgy, Diffusion bonding, In-situ processes, applications of MMCs.

UNIT IV **9 Hours**

CERAMIC MATRIX COMPOSITES

Need for CMCs, Processing of CMCs- cold pressing and sintering, hot pressing, infiltration, chemical vapor deposition and chemical vapor impregnation, sol-gel and polymer pyrolysis, high temperature synthesis properties and applications in aerospace and space fields. Introduction to carbon carbon matrix composites.

UNIT V **9 Hours**

MECHANICS FAILURE ANALYSIS AND DESIGN

Characteristics of Fiber-reinforced Lamina-Laminates- Interlaminar stresses-Static Mechanical Properties-Fatigue and Impact Properties-Failure Predictions-Failure Theories-Laminate Design Consideration-Classical lamination Theory-Analysis of Laminated Composite Beams- Plates - Shells Vibration and Stability Analysis- Finite Element Method of Analysis-Analysis of Sandwich structures.

Total: 45 Hours

Reference(s)

1. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, Marce Dekker Inc, 2007
2. K. Autar Kaw, Mechanics of Composite Materials, CRC Press, 2013.
3. B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, Joh Wiley and Sons, New York, 2017.
4. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2016.
5. K.K. Chawla, Composite materials, Springer Verlag, 2012
6. Robert M. Jones, Mechanics Of Composite Materials, CRC Press,2018.

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.

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. Interpret CAD/CAM/CAE fundamentals, product cycle models, and geometric transformations with projections in computer graphics applications.
2. Construct geometric models using curves (Hermite, Bezier, B-Spline), surfaces, and solids by employing 2D drafting and 3D modeling software.
3. Differentiate graphics display devices and algorithms for hidden line, surface, and solid removal, along with shading, coloring, and animation techniques.
4. Apply assembly modeling concepts including constraints, degrees of freedom, and tolerance analysis to advanced modeling techniques such as freeform modeling, generative design, and rendering.
5. Evaluate CAD data exchange formats, database standards, and communication protocols for ensuring interoperability across CAD/CAE/CAM systems.

Articulation Matrix

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

UNIT I **9 Hours**

FUNDAMENTALS

Introduction to CAD/CAM/CAE, Graphics Input devices-cursor control Devices, Digitizers, Keyboard terminals, Image scanner, Speech control devices and Touch, panels, Product cycle, Sequential and Concurrent Engineering, CAD - Architecture, Tools, applications - Coordinate systems - Two and Three-dimensional Transformations - Translation - Scaling - Reflection - Rotation, Windowing - clipping and Viewing, Orthographic and perspective projections.

UNIT II **10 Hours**

CURVES AND GEOMETRIC MODELING

Representation of curves, Properties of curve design and representation, - Hermite, Bezier, B-Spline and rational curves, Surface Modeling, surface patch, Bezier and B spline surface. Fundamentals of Solid Modelling, Boundary representation and Constructive Solid Geometry, Sweep representation, Comparison of wireframe, surface and solid models, Basic application commands for 2D drafting software like AutoCAD & 3D solid modeling software like Solidworks, Autodesk Inventor, PTC Creo, Catia etc.

UNIT III **9 Hours**

VISUAL REALISM

Graphics display devices, Cathode Ray Tube, Random & Raster scan display, Color CRT monitors, Direct View Storage Tubes, Flat Panel display, Hard copy printers and plotters, Coherence types. Hidden line removal algorithm, Priority and Area oriented algorithms. Hidden Surface removal algorithm, Depth buffer and Warnock"s algorithms. Hidden solid removal algorithm, Ray Tracing algorithm, Shading and Coloring, types. Computer Animation.

UNIT IV **8 Hours**

ASSEMBLY MODELING AND ADVANCED MODELING TECHNIQUES

Assembly modeling, Interference of Positions and orientations, CAD Tolerance Analysis, geometrical Mass Properties, degree of freedom, Constraints and Simulation concepts. Introduction to freeform modeling, rendering, generative design, technical drawing.

UNIT V **9 Hours**

DATA EXCHANGE FORMATS

Database Management System, CAD Standards, File types, DXF, STL, STEP, IGES, PDES, PARASOLID, ACIS, Data, Database Structures, Types. Communication Standards, Data Exchange between CAD/CAE/CAM Systems, Requirements for the Exchange, Exchange Methods.

FOR FURTHER READING

Graphics manipulation and Editing, Parametric Representation of Synthetic Curves, Applications of CAD in FEM.

Total: 45 Hours

Reference(s)

1. Ibrahim Zied, CAD/CAM-Theory and Practice, Tata McGraw Hall Publishing Company Pvt. Ltd., New Delhi, 2009.
2. Donald Hearn, M. Pauline Baker, Computer Graphics, Prentice Hall of India, New Delhi, 2014.
3. Richard M. Lueptow, Graphics Concepts for Computer-Aided Design, Pearson Education, India, 2nd edition, 2007.
4. William M. Neumann, Robert F. Sproul, Principles of Computer Graphics, Tata McGraw Hall Publishing Company Pvt Ltd., New Delhi, 2005.
5. Mikell P. Groover, Emory W. Zimmers, CAD/CAM Computer-Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2007.
6. https://www.autodesk.com/certification/learn/course/fusion360-generative-design-intro-expert

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

Course Outcomes (COs)

1. Apply the fundamental principles of mechanical vibrations to model and interpret the behavior of single degree of freedom systems under free and forced conditions within a defined mechanical context.
2. Analyze two-degree freedom systems using concepts such as mode shapes, coordinate coupling, and orthogonality to predict system response under various excitation conditions.
3. Formulate mathematical models for multi-degree freedom systems and solve for natural frequencies and mode shapes using exact and approximate methods within the course timeline.
4. Demonstrate the vibration characteristics of continuous systems like strings, rods, and beams by applying analytical methods such as Rayleigh's and Rayleigh-Ritz method.
5. Design vibration measurement and control systems using appropriate sensors, transducers, and signal processing tools to monitor and interpret mechanical vibrations in practical applications.

Articulation Matrix

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

UNIT I **9 Hours**

SINGLE DEGREE OF FREEDOM (SDF)

Fundamentals of vibration. Single Degree of Freedom - Responses of undamped free vibration - Viscous damping - Damped free vibration - Reponses of undamped forced vibration and damped forced vibration - Response of damped system under base excitation - Rotating unbalance.

UNIT II **9 Hours**

TWO DEGREE FREEDOM SYSTEM (TDF)

General equation of motion - Principal mode of vibration - Coordinate coupling - Orthogonolity principle - Rectilinear and torsional systems - Natural frequencies of undamped free vibration systems - Equations of motion for forced vibrations and damped free vibration - Dynamic vibration absorber - Lagrange''s equation

UNIT III **9 Hours**

MULTI-DEGREE FREEDOM SYSTEM (MDF)

Modelling of MDF systems by equations of motion from Newton''s law - Influence coefficients - Stiffness coefficients and Generalised coordinate - Eigenvalue problems and solution. Approximate methods in MDF, Dunkerley''s method, matrix iteration method, Rayleigh''s and Holzer''s method.

UNIT IV **9 Hours**

VIBRATION OF CONTINUOUS SYSTEMS

Introduction - Transverse vibration of string - axial vibration of a rod - Torsional vibration of shaft - Lateral vibration of beam - Rayleigh''s Method and Rayleigh-Ritz method.

UNIT V **9 Hours**

VIBRATION MEASUREMENT AND CONTROL

Vibration Measuring Devices: seismometer, accelerometer and velometers-Vibration exciters: mechanical, hydraulic, electromagnetic and electrodynamic-Frequency measuring instruments: single reed, multi reed and stroboscope. Vibration meters and sound level meters. Signal conditioning devices: Filters, Amplifiers, Modulators/Demodulators, ADC/DAC. Signal analysis devices. Vibration recording and display devices

Total: 45 Hours

Reference(s)

1. Rao, S. S. Mechanical Vibrations, Pearson Education, 2011.
2. William Thomson, Marie Dillon Dahleh, Theory of Vibrations with Applications, Pearsons Education 2014.
3. Graham Kelly G and Shashidar K. Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007.
4. D.J Inman, Engineering Vibration, Pearson International Education, 2014.
5. https://www.youtube.com/@introductiontomechanicalvi2886/videos.

21ME005 / 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.

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

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

PSO1.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. Assess the fundamental concepts of friction and wear to apply their influence on mechanical interactions.
2. Apply surface contact characteristics to evaluate the suitability of bearings in specified engineering applications.
3. Infer the role of friction in tribological systems to enhance performance and reduce energy loss.
4. Analyze wear mechanisms and quantify wear rates to assess material performance under operational conditions.
5. Interpret lubrication requirements and correlate them with suitable lubricant types for specific tribological applications.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Introduction to Tribology, Factors influencing Tribological phenomena, Properties of materials relevant to friction and wear.

UNIT II **9 Hours**

CONTACT BEHAVIOUR OF SURFACE

Engineering surfaces - Surface characterization, Contact of engineering surfaces: Hertzian and nonhertzian contact, Contact pressure and deformation in non-conformal contacts.

UNIT III **9 Hours**

FRICTION

Causes of friction, Stick-slip friction behavior and friction instability, sliding and rolling friction, frictional heating and temperature rise, Friction measurement techniques.

UNIT IV **9 Hours**

WEAR AND ITS MEASUREMENT

Wear and wear types, Mechanisms of wear, wear of metals and non-metals. wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage, wear measurement and controlling techniques.

UNIT V **11 Hours**

LUBRICATION

Lubricants- physical and chemical properties, types of additives. Selection of lubricants, Hydrodynamic lubrication-principle and application, Reynolds equation. Elasto hydrodynamic Lubrication- Principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin Equation.

Total: 45 Hours

Reference(s)

1. Prasanta Sahoo, Engineering Tribology, 3rd edition, Prentice-Hall India, New Delhi, 2011.
2. Bharat Bhushan, Introduction to Tribology, 2nd edition, Wiley Publication, 2013.
3. I.M. Hutchings, Friction and Wear of Engineering Material, Edward Arnold, London, 2002.
4. Neale, M.J., Bearings-Tribology Hand Book, Butterworth Heinemann, 2005.
5. T.A. Stolarski, Tribology in Machine Design, Industrial Press Inc., 2000.
6. http://www.nptel.iitm.ac.in/downloads/110105039/

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.

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

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

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

Course Outcomes (COs)

1. Analyze material failures, use suitable testing methods, and select appropriate materials and processes for effective and reliable design under various conditions.
2. Apply fracture mechanics to study ductile and brittle failures, evaluate crack growth using elastic and plastic methods, and assess structural safety using key fracture parameters.
3. Assess the dynamic and time-dependent fracture behavior in materials, and determine fracture toughness using experimental methods such as K-R curve testing, J-integral, and CTOD measurements.
4. Investigate different types of wear and their failure mechanisms, evaluate wear behavior under various conditions including elevated temperatures, and assess the effects of friction, creep, and environmental factors on material performance.
5. Develop reliability concepts and statistical tools such as Poisson, exponential, and Weibull distributions to predict and extend system life, and perform failure analysis using FMEA and fault tree analysis for identifying and ranking failure modes.

Articulation Matrix

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

UNIT I **10 Hours**

MATERIALS AND DESIGN

Introduction, causes of failures, classification, steps in failure analysis, tools, sample selection and treatment, materials analysis, equipment, Metallography, commonly used NDT methods. Effect of component geometry and shape factors, designing with high strength and low toughness materials, designing for hostile environments; Materials selection in design; Processes and their influence on design, systematic process selection.

UNIT II **9 Hours**

FRACTURE MECHANICS

Ductile fracture, brittle fracture, cleavage-fractography, ductile-brittle transition, fracture mechanics approach to design-energy criterion, stress intensity approach; Time dependent crack growth and damage; Linear elastic fracture mechanics: Griffith theory, energy release rate, instability and R-curve, stress analysis of cracks-stress intensity factor, K-threshold, crack growth instability analysis, crack tip stress analysis; Elastic plastic fracture mechanics: Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD.

UNIT III **8 Hours**

FRACTURE TOUGHNESS

Dynamic fracture, rapid loading of a stationary crack, rapid crack propagation, dynamic contour integral, creep crack growth-C Integral, viscoelastic fracture mechanics, viscoelastic J integral; Determination of fracture toughness values: Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing.

UNIT IV **9 Hours**

WEAR FAILURES

Types of wear, different methods of wear measurement, analysis of wear failures, wear at elevated temperatures, wear of different materials, role of friction on wear, stick slip friction, creep, stress rupture, elevated temperature fatigue, environment induced failure.

UNIT V **9 Hours**

FAILURE ANALYSIS TOOLS

Reliability concept and hazard function, life prediction, life extension, application of Poisson, exponential and Weibull distributions for reliability, bath tub curve, parallel and series systems, MTBF, MTTR, FMEA-design FMEA, process FMEA, analysis of causes of failure modes, ranks of failure modes; Fault tree analysis; Industrial case studies on FMEA.

Total: 45 Hours

Reference(s)

1. Anderson T L , "Fracture Mechanics: Fundamentals and Applications", 4th Edition, Taylor and Francis, 2017.
2. Shigley and Mische , "Mechanical Engineering Design", 5th Edition, McGraw Hill, 2011.
3. John M Barsoom and Stanley T Rolte , "Fracture and Fatigue Control in Structures", 3rd Edition, American Society For Testing & Materials, 1999.
4. Balbir S. Dhillon , "Applied Reliability and Quality: Fundamentals, Methods and Procedures", 1st Edition,Springer Series in Reliability Engineering, 2010.
5. ASM Metals Handbook Volume 11 , "Failure Analysis and Prevention", 10th Edition, ASM International, 2002.

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 study the different types of chillers, cooling towers, pumps required for chilled water circulation
- To provide awareness on equipment selection and erection of HVAC system

Programme Outcomes (POs)

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

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

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

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

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

Course Outcomes (COs)

1. Apply the basic principles of air conditioning and refrigeration systems to interpret psychrometric properties and processes for different HVAC types.
2. Analyse the heat load in buildings by estimating the heat gains in indoor/outdoor conditions, envelope exposure, and internal/external.
3. Design air distribution systems by selecting and sizing ducts, diffusers, and ventilation components based on air flow requirements and building layout
4. Interpret the components and layout of chilled water systems including chillers, pumps, and piping arrangements to assess flow performance and system efficiency.
5. Select suitable HVAC equipment such as AHUs, FCUs, chillers, and cooling towers, and plan their installation and drafting for efficient system operation.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO HVAC

Air conditioning systems - Concept and Principle, Types - Window, Split Air conditioning, VRV, Central Air Conditioning System. Refrigeration - Refrigerant cycle, Refrigerant - Types, Evaporating & Condensing properties. Psychometric chart - Cooling, Heating, Humidification Methods, Dehumidification Methods, Properties of Air (DBT, %RH, WBT, DPT, ENTHALPY)

UNIT II **9 Hours**

HEAT LOAD ESTIMATION

Basics of Heat transfer in a building envelop. Understanding of Outdoor / Indoor Conditions, Temperature Requirements. Heat Load - Exposure of Wall, Latitude of Location, Yearly Range, Daily Range, Factors effecting the loads estimate. Heat Gain and Loss - Internal and External Sources and Calculations

UNIT III **9 Hours**

DESIGN OF AIR DISTRIBUTION SYSTEM

Components of Air distribution system - Ducts, Diffusers, Vanes - Types, Selection, Requirements and Calculations. Duct designing methods and Fan Selection. Ventilation - Types, Components. Exhaust System - Kitchen and Parking ventilation in case of fire

UNIT IV **9 Hours**

CHILLED WATER SYSTEM DESIGN

Introduction to Chilled and Hot water system - Chiller - Classification and Arrangements. Cooling Tower - Types and Arrangements. Pump and its classification - water velocity calculations. Piping - Fitting, Components, Valves and Friction Losses.

UNIT V **9 Hours**

EQUIPMENT SELECTION AND ERECTION

Classification and Selection - AHU&FCU, Chiller, Condenser, Cooling Tower, Expansion Tank. Detailing and Installation - Chillers, Air handling units, Package units, Fan coil units and Condensing units. Drafting of HVAC Systems.

Total: 45 Hours

Reference(s)

1. W. Larsen Angel , HVAC Design Sourcebook, Tata McGrawhill, Second Edition, 2020
2. Roger Haines, Lewis Wilson, HVAC Systems Design Handbook, McGraw-Hill Education, 5th edition, 2009
3. Herbert W. Stanford III, HVAC Water Chillers and Cooling Towers: Fundamentals, Application, and Operation, CRC Press, Second Edition, 2017
4. Robert McDowall, Fundamentals of HVAC Systems, Elsevier Science, CBS Publishers and Distributors pvt Ltd, Second Edition, 2006
5. Mohsen Sheikholeslami Kandelousi, HVAC System. Intechopen, 2018
6. Design Guide for Heating, Ventilating, and Air Conditioning Systems, U.S. Department of the Interior Bureau of Reclamation, 2006

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 an efficient gating and risering system for sand moulding by applying principles of casting design and defect control.
2. Select appropriate casting processes for a given component and justify the use of advanced casting techniques based on process characteristics and applications.
3. Apply metallurgical principles to analyze slip, twinning, and mechanisms of plastic deformation under varying metal forming conditions.
4. Choose and evaluate suitable bulk deformation processes such as forging, rolling, extrusion, and drawing based on application requirements and force calculations.
5. Apply the principles of conventional and high energy rate forming (HERF) processes to select suitable presses and analyze sheet metal formability and powder metallurgy applications.

Articulation Matrix

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

UNIT I **7 Hours**

CASTING DESIGN

Introduction - Principles and Design considerations in casting, Elements of a gating system, design of gating and risering, designing for directional solidification - casting defects, causes and its inspection - hot coating, cold coating and warm coating.

UNIT II **10 Hours**

ADVANCED CASTING PROCESSES

Investment casting, Shell mould casting, Continuous casting process-Reciprocating moulding process, direct chill process, materials, defects and its applications. Centrifugal casting- Types of centrifugal casting, calculation of rotation speed of the mould equipment. Die casting - types, dies for permanent mould castings, machines, design consideration for die casting and low pressure die casting.

UNIT III **6 Hours**

THEORY OF METAL FORMING

Metallurgical aspects of metal forming - slip twining - mechanics of plastic deformation - effects of temperature - strain rate - microstructure and friction in metal forming - spring back effect - yield criteria and their significance - classification of metal forming processes.

UNIT IV **10 Hours**

BULK DEFORMATION PROCESSES

Forging and Rolling - Introduction, classification, equipment types, die design and its types, press tools, processes, parameters and force calculation. Classification of extrusion processes tool, equipment and principle of these processes - influences of friction - Extrusion force calculation - Defects and analysis - Rod/wire drawing tool equipment and principle of processes - defects - Tube drawing and sinking processes - Mannesmann processes of seamless pipe manufacturing.

UNIT V **12 Hours**

SHEET METAL FORMING AND POWDER METALLURGY PROCESSES

Classification - conventional and HERF processes - Presses - types and selection of presses formability - diagram formability of sheet metals - Principle, process parameters equipment and application of the following processes - Deep drawing, spinning - stretch forming, plate bending, press brake forming Explosive forming - electro hydraulic forming - magnetic pulse forming - Powder Metallurgy Technique - Advantages - applications - Powder preform forging - powder rolling Tooling, process parameters and applications.

Total: 45 Hours

Reference(s)

1. Jain P. L, Principles of Foundry Technology, Tata McGraw Hill Publications, New Delhi, 2014.
2. Heine R.W, Carl Loper and Rosenthal P.C, Principles of Metal Casting, Tata McGraw Hill Publications, New Delhi, 2012.
3. J. P. Kaushish, Manufacturing process., Prentice Hall of India Learning Private Limited, second edition, New Delhi, 2015
4. Dieter G. E, Mechanical Metallurgy, Tata McGraw Hill Company, New Delhi,2015
5. Mikell P. Groover, Automation, Production System and Computer Integrated Manufacturing, Prentice Hall of learning, New Delhi, 2015

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.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Apply the basic principles of non-traditional machining processes to the indicate its need and classification.
2. Illustrate the working principles, equipment, and process parameters of mechanical energy-based machining processes such as AJM, WJM, and USM.
3. Interpret the working principles, power circuits, and tool-material interactions involved in Electrical Discharge Machining and Wire EDM for conductive material machining.
4. Assess the electro-chemical and chemical machining techniques for their precision, material suitability, and machining efficiency.
5. Analyze the use of thermal energy-based machining processes (LBM, EBM, PAM) for cutting hard-to-machine materials in advanced manufacturing scenarios.

Articulation Matrix

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

UNIT I **7 Hours**

INTRODUCTION

Introduction - Need - Classification - Energies employed in the processes – Working principles, Advantages, Limitations, Applications of Abrasive jet machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (EBM), Electro-chemical machining (ECM), Electron beam machining (EBM), Laser beam machining (LBM), Plasma arc machining (PAM).

UNIT II **10 Hours**

MECHANICAL ENERGY BASED PROCESSES

Abrasive Jet Machining, Water Jet Machining and Ultrasonic Machining - Working Principles, Equipment, Process parameters, Material removal rate, Applications, High pressure abrasive water jet machining

UNIT III **10 Hours**

ELECTRICAL ENERGY BASED PROCESSES

Electric Discharge Machining - Working Principles, Equipment, Process Parameters, Material removal rate, Electrode / Tool, Power Circuits, Tool Wear, Dielectric, Flushing, Wire cut EDM, EDM drill-Applications.

UNIT IV **10 Hours**

CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES

Chemical machining-Etchants, Maskants techniques. Electro-chemical machining - - Working principle, Equipment, Process Parameters, Material removal rate, Electrical circuit. Electro-chemical grinding - Electro-chemical honing - Applications.

UNIT V **8 Hours**

THERMAL ENERGY BASED PROCESSES

Laser Beam machining, Plasma Arc Machining - Principles, Equipment. Electron Beam Machining - Principles, Equipment, Types, Beam control techniques, Material removal rate-Applications.

Total: 45 Hours

Reference(s)

1. P. K. Mishra, Non Conventional Machining, Narosa Publishing House, New Delhi, 2018
2. P. C. Pandey and H.S.Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2021.
3. Joao Paulo Davim, Nontraditional Machining Processes: Research Advances, Springer, NewYork, 2013.
4. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
5. Vijaya Kumar Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi,2023.
6. Hassan El-Hofy, Advanced Machining Processes: Non-traditional and Hybrid Machining Processes, McGraw-Hill Professional, New Delhi, 2005

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.

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 principles, types, and applications of gas welding and arc welding processes.
2. Apply the concepts of welding metallurgy in the design and testing of weldments to ensure structural integrity and performance.
3. Demonstrate understanding of solid-state welding processes, including their working principles, parameters, and practical uses.
4. Evaluate special welding processes and assess the role of welding automation in enhancing mass production efficiency.
5. Analyze the process parameters and industrial applications of various resistance welding techniques.

Articulation Matrix

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

UNIT I **9 Hours**

WELDING PRINCIPLES, DESIGN, GAS AND ARC WELDING PROCESSES

Classifications of Welding Processes - Power sources, Arc characteristics, V-I characteristics, Metal transfer modes, electrodes and fluxes. Types of Weld joints, Weld position, Welding symbols. Gas welding Types, Arc welding: Shielded Metal Arc Welding (SMAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW/MIG), Submerged Arc Welding (SAW), Flux Cored Arc welding and Plasma Arc Welding (PAW) - Advantages, limitations and its applications, Welding Defects.

UNIT II **9 Hours**

RESISTANCE WELDING PROCESSES

Spot welding (RSW), Seam welding (RSEW), Projection welding (PW), Resistance Butt welding, Flash Butt welding (FW), Percussion welding, High frequency resistance welding process and High frequency induction welding process - Advantages, limitations and its applications.

UNIT III **9 Hours**

SOLID STATE WELDING PROCESSES

Forge welding (FOW), Friction welding (FRW), Explosive welding (EXW), Ultrasonic welding (USW), Cold welding (CW), Diffusion bonding (DFW), Roll welding (ROW) and Hot pressure welding (HPW) processes - Advantages, limitations and its applications.

UNIT IV **9 Hours**

SPECIAL WELDING PROCESSES AND WELDING AUTOMATION

Thermit welding (TW), Atomic Hydrogen welding (AHW), Electron beam welding (EBW), Laser Beam welding (LBW), Friction stir welding (FSW), Under Water welding, Wire Arc Additive Manufacturing, Cladding, Welding automation in aerospace and automobile industry.

UNIT V **9 Hours**

WELDABILITY, TESTING OF WELDMENTS, CODES AND STANDARDS

Weldability of Aluminium, Copper, Cast Iron and Stainless steels. Destructive tests: Tensile Test, Bend Test, Impact Test, Hardness Testing, Fatigue Test. Non-destructive testing: Visual Inspection, Liquid Penetrant Testing, Magnetic Particle Testing, Radiographic Testing and Ultrasonic Testing of weldments. Codes and Standards: Introduction to codes and standards, Welding and Welder Qualification, Procedure Qualification Record (PQR), Welding Procedure Specification (WPS), and Welder Performance Qualification (WPQ).

Total: 45 Hours

Reference(s)

1. David H. Phillips, Welding Engineering: An Introduction, Wiley, 2016
2. Parmer R.S., Welding Engineering and Technology, 3rd edition, Khanna Publishers, New Delhi, 2022
3. Parmer R.S., Welding Processes and Technology, Khanna Publishers, New Delhi, 2004.
4. Nadkarni S.V., Modern Arc Welding Technology, 1st edition, Oxford IBH Publishers, 2008.
5. AWS Welding Hand Book, Welding Process, 10th Edition, Vol- 1&2, 201

21ME011 / 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.

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. Apply process planning principles to select appropriate materials, machines, and production methods for manufacturing operations.
2. Assess the objectives, importance, and procedures of cost estimation and distinguish between costing and estimation techniques.
3. Compute various cost elements including direct, indirect, overhead expenses, and depreciation using standard methods.
4. Estimate the production cost in forging, welding, gas cutting, and foundry operations considering material, labour, and overhead costs.
5. Calculate the machining time for common machining operations such as turning, drilling, boring, shaping, milling, and grinding.

Articulation Matrix

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

9 Hours

UNIT I

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 / 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.

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

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

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

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

Course Outcomes (COs)

1. Interpret the evolution of manufacturing and management systems, differentiate between dedicated and open systems, and explain CAD/CAM integration with communication protocols.
2. Illustrate parts using GT coding systems (DCLASS, MICLASS, OPITZ), analyze process planning approaches, and apply computer-aided process planning for cellular manufacturing.
3. Demonstrate shop floor control and data collection methods, and evaluate FMS components, layouts, and material handling systems for improving manufacturing flexibility.
4. Apply system modeling tools such as IDEF and activity cycle diagrams, and analyze CIM implementation strategies, architectures, and data communication techniques including LAN topologies.
5. Investigate open system standards (MAP/TOP), develop relational database models, and evaluate database applications to enhance data management in CIM environments.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION

The changing manufacturing and management scene, External communication, Islands of automation and software, dedicated and open systems, manufacturing automation protocol, introduction to CAD/CAM integration

UNIT II **10 Hours**

GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING

Classification and coding - DCLASS, MICLASS and OPITZ coding systems. Facility design using G.T. - Benefits of G.T - cellular manufacturing. Process planning, role of process planning in CAD/CAM integration- approaches to computer aided process planning- variant approach and generative approaches.

UNIT III **9 Hours**

SHOP FLOOR CONTROL AND FMS

Shop floor control phases -factory data collection system -automatic identification methods- Bar code technology - automated data collection system. FMS- components of FMS- types -FMS workstation-material handling and storage systems- FMS layout-computer control systems-application and benefits

UNIT IV **9 Hours**

CIM IMPLEMENTATION AND DATA COMMUNICATION

System modelling tools- ICAM definition (IDEF) models, activity cycle diagram, CIM open system architecture (CIMOSA) - manufacturing enterprise wheel- CIM architecture- Product data management, implementation-software. Communication fundamentals- local area networks (LAN) -topology -LAN implementations - network management and installations.

UNIT V **9 Hours**

OPEN SYSTEM AND DATABASE FOR CIM

Open systems-open system inter-connection - manufacturing automation protocol and technical office protocol-(MAP/TOP). Development of databases - database terminology - architecture of database systems- data modeling and data associations -relational data bases - database operators - advantages of data base and relational database

Total: 45 Hours

Reference(s)

1. Mikell P Groover,Automation of production systems and computer integrated manufacturing, Pearson Education, United States of America, 2008.
2. Lee Kunwoo, CAD,CAM,CAE systems, Addison Wesley, United States of America, 1999.
3. Kant Vajpayee S, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi, 2003.
4. Radhakrishnan P, Subramanyan S and Raju V, CAD,CAM,CIM, Second Edition New Age International Pvt. Ltd, New Delhi, 2000.

21ME013 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To develop the ability to generate 3D CAD models using different methods.
- To explain and apply the constructional features of CNC machines and develop programs for simple components.
- To provide comprehensive knowledge of generic processes and benefits of Additive Manufacturing (AM).
- To familiarize students with materials and process parameters in liquid- and solid-based AM techniques.
- To explore powder-based methodologies, emerging trends, and case studies in AM applications across industries.

Programme Outcomes (POs)

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

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

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

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

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

PSO1. 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 CAD modeling techniques (wireframe, surface, and solid modeling) to design mechanical components using Constructive Solid Geometry (CSG) and Boundary Representation (B-rep) methods.
2. Analyse CNC machine operations and formulate G-code programs for turning and milling operations using linear and circular interpolation.
3. Develop an understanding of additive manufacturing (AM) processes and analyse their advantages over traditional CNC machining.
4. Design and develop 3D models for AM by converting CAD files into STL format, verifying and repairing them for defect-free part fabrication.
5. Analyse different AM systems and apply them in reverse engineering, medical, automotive, aerospace, and electronics industries.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
3	3	2	3	-	-	-	-	-	-	-	-	-	2	2	-
4	2	2	3	2	3	-	-	-	-	-	-	-	2	2	-
5	2	2	2	2	3	-	-	-	-	-	-	-	2	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.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2015.
5. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, 2015.

21ME014/ 21MEM14 OPERATIONS MANAGEMENT 3 0 0 3

Course Objectives

- To understand the concept of production and operations management.
- To familiarize the various forecasting techniques.
- To make the decision on capacity and location planning.
- To impart the knowledge on aggregate planning and master scheduling.
- To emphasize the need of material management and inventory control.

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply operations management principles to identify production system types, evaluate productivity factors, and solve decision-making problems using appropriate models and techniques.
2. Apply appropriate forecasting techniques to assess time series data, forecast accuracy, and support decision-making in operations management.
3. Analyze capacity and location planning decisions by evaluating influencing factors, measuring requirements, and assessing alternative solutions to optimize operational efficiency.
4. Investigate aggregate planning strategies and master scheduling methods to align production capabilities with demand while optimizing resource utilization and operational efficiency.
5. Analyze the components of materials management and inventory control systems to evaluate inventory models and enhance the efficiency of purchasing, storage, and material planning decisions

Articulation Matrix

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

UNIT I **9 Hours**

OPERATIONS MANAGEMENT

Introduction, Functions within business organizations, the operation management function, Classification of production systems, Productivity, factors affecting productivity. The decision process, characteristics of operations decisions, use of models, decision making environments, graphical linear programming, analysis and trade-offs.

UNIT II **9 Hours**

FORECASTING

Steps in forecasting process, approaches to forecasting, forecasts based on judgment and opinion, analysis of time series data, accuracy and control of forecasts, choosing a forecasting technique, elements of a good forecast.

UNIT III **9 Hours**

CAPACITY AND LOCATION PLANNING

Importance of capacity decisions, defining and measuring capacity, determinants of effective capacity, determining capacity requirement, developing capacity alternatives, evaluating alternatives, Need for location decisions, nature of locations decisions, general procedure for making locations decisions, evaluating locations decisions, facilities layout, need for layout decisions, types of processing.

UNIT IV **9 Hours**

AGGREGATE PLANNING AND MASTER SCHEDULING

Aggregate planning, Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning, graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

UNIT V **9 Hours**

MATERIALS MANAGEMENT AND INVENTORY CONTROL

Material Management, Components of Integrated Material Management, Materials planning, Inventory Control, Purchase Management, Stores Management; Inventory control, Models of Inventory controls, Purchase model , Manufacturing model.

Total: 45 Hours

Reference(s)

1. R. Panneerselvam, Production and Operations Management, PHI, 2018.
2. R.B. Khanna, Production and operations management, PHI, 2015.
3. Jay Heizer, Barry Render, Operations Management, Pearson College Division, 2013.
4. N. Chary, Production and operations management, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
5. Joseph G Monks, Operation Management, McGrew Hill Publication, International Edition, 1987.
6. Everett E. Adams, Ronald J. Ebert, Production and Operations Management, Prentice Hall of India Publications, Fourth Edition, 1989.

21ME015 / 21MEM15 SUPPLY CHAIN MANAGEMENT 3 0 0 3

Course Objectives

- To understand the individual processes of supply chain management and their inter relationships within individual companies and across the supply chain
- To understand the components of supply chain management
- To understand the tools and techniques useful in implementing supply chain management
- To understand the concept of retail logistics and contemporary issues.
- To understand the concept of ware house management.

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

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

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Course Outcomes (COs)

1. Demonstrate the application of logistics and supply chain management tools and techniques in practical scenarios.
2. Develop effective plans for retail distribution logistics systems considering demand patterns and delivery constraints.
3. Implement order management and reverse logistics strategies in alignment with operational efficiency goals.
4. Analyze the impact of logistics drivers and evaluate contemporary practices to optimize supply chain performance.
5. Integrate warehouse functions into overall logistics systems to enhance inventory flow and service levels.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	2	-	2	-	-	-	-	-	2	-
2	2	2	3	-	-	2	-	3	-	-	2	-	-	2	-
3	3	-	-	-	1	-	-	-	-	-	-	-	-	2	-
4	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
5	2	2	3	-	-	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 / 21MEM16 TOTAL QUALITY MANAGEMENT 3 0 0 3

Course Objectives

- To learn concepts, dimension quality and philosophies of TQM
- To study the TQM principles and its strategies
- To learn the seven tools of statistical quality and management
- To impart knowledge on TQM tools for continuous improvement
- To introduce an international quality management system

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Illustrate the fundamental principles, philosophies, and historical evolution of Total Quality Management to implement continuous process improvement.
2. Apply effective strategies for leadership, customer satisfaction, employee involvement, and supplier partnerships to enhance organizational quality culture.
3. Analyze process variations and performance using statistical quality control tools such as control charts and capability studies to ensure product consistency.
4. Develop and apply tools like Benchmarking, QFD, TPM, and FMEA to solve quality-related issues and improve product and process performance.
5. Design quality management systems in accordance with ISO standards and audit requirements to ensure organizational compliance and continuous improvement.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Definition of Quality - Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Obstacles to TQM - Quality Statements - Strategic Planning - Deming Philosophy - Crosby philosophy - Continuous Process Improvement - Juran Trilogy - PDSA Cycle - 5S - Kaizen.

UNIT II **9 Hours**

TQM PRINCIPLES

Principles of TQM - Leadership Concepts - Role of Senior Management - Quality Council - Customer satisfaction - Customer Perception - Customer Complaints - Customer Retention - Employee Involvement - Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal - Benefits - Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating.

UNIT III **9 Hours**

STATISTICAL PROCESS CONTROL (SPC)

The seven tools of quality - Statistical Fundamentals - Measures of Central Tendency and Dispersion - Population and Sample - Normal Curve - Control Charts for variables X bar and R chart and attributes P - nP - C and u charts - Industrial Examples - Process capability - Concept of six sigma - New seven Management tools

UNIT IV **9 Hours**

TQM TOOLS

Benchmarking - Quality Function Deployment (QFD) - House of Quality - QFD Process and Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM) - FMEA - Stages of FMEA - Case studies

UNIT V **9 Hours**

QUALITY SYSTEMS

Need for ISO 9000 and Other Quality Systems - Elements - Implementation of Quality System - Documentation - Quality Auditing - ISO 9000:2015 - ISO 9001:2015 and ISO 9004:2018 - TS 16949 - ISO 14000 - ISO 50001 - Concept - Requirements and Benefits.

Total: 45 Hours

Reference(s)

1. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield, Mary Besterfield, Hemant Urdhwareshe, Rashmi Urdhwareshe, Total Quality Management, Pearson Education, 5th Edition, 2018.
2. D.R. Kiran, Total Quality Management, Butterworth-Heinemann, 1st Edition, 2017.
3. Pankaj Lochan, Organizational Quality Management, TQM Deployment perspectives from manufacturing & process industry, TQM Publication Book 2, 2020.
4. Sayeda Begum, Chandrasekharan Rajendran, Prakash Sai L, K. Ganesh, Sanjay Mohapatra, Total Quality Management In Higher Education: Study Of Engineering Institutions, Routledge India, 1st Edition, 2020.
5. Sunil Luthra, A Dixit Garg, A Ashishgarwal, Sachin K Mangla, CRC Press, 1st Edition, 2020.
6. Poornima M Charantimath, Total Quality Management, Pearson Education, 4th edition, 2022.

21ME017/ 21MEM17 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. Assess conventional and lean manufacturing approaches, and explain the principles and key elements of lean manufacturing including foundational lean tools.
2. Design cellular layouts and implement Just-in-Time (JIT) and Kanban systems while applying the core principles and pillars of Total Productive Maintenance (TPM).
3. Apply techniques for setup time reduction, implement 5S methodology, and use Value Stream Mapping (VSM) and Total Quality Management (TQM) principles for process improvement.
4. Analyze quality issues using Six Sigma tools, including cost of quality analysis, quality control tools, seven management tools, and Failure Mode and Effect Analysis (FMEA).
5. Implement the DMAIC (Define, Measure, Analyze, Improve, Control) methodology and integrate Lean Six Sigma principles to improve manufacturing performance and quality.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
2	2	2	3	2	-	-	-	-	-	-	-	-	-	2	-
3	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	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 / 21MEM18 ENGINEERING ECONOMICS 3 0 0 3

Course Objectives

- Learn basics Engineering Economics, types of costs
- Impart different investment situations. economically sound decisions
- Study investment alternatives
- Learn market analysis to take optimal decisions
- Know the macro economics, taxes and inflation

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the principles of micro and macroeconomics to interpret economic systems, opportunity costs, organizational objectives, and production possibilities in a business context.
2. Analyze demand and supply functions by evaluating elasticity, demand forecasting methods, and consumer behavior models to support managerial decision-making.
3. Evaluate production and cost concepts, including returns to scale, cost–revenue analysis, and break-even models, to support effective resource allocation and operational efficiency.
4. Compare market structures and justify pricing methods, while applying capital budgeting techniques (NPV, IRR, ARR, Payback) to assess long-term investment decisions.
5. Interpret macroeconomic indicators such as national income, inflation, deflation, taxation, and fiscal/monetary policies to assess their impact on organizational financial accounting and decision-making.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to Micro and Macroeconomics - Kinds of Economic Systems - Production Possibility Frontier - Opportunity Cost - Objective of Organizations - Kinds of Organization

UNIT II **9 Hours**

DEMAND AND SUPPLY

Functions of Demand and Supply - Law of diminishing Marginal Utility - Law of Demand and Supply - Elasticity of Demand - Demand Forecasting Methods - Indifference curve.

UNIT III **9 Hours**

PRODUCTION AND COST

Production Function - Returns to Scale - Law of Variable Proportion - Cost and Revenue concepts and Cost Curves - Revenue curves - Economies and Dis-economies of scale - Break Even point.

UNIT IV **9 Hours**

MARKET STRUCTURE

Market Structure - Perfect Competition - Monopoly - Monopolistic - Oligopoly - Components of Pricing - Methods of Pricing - Capital Budgeting IRR - ARR - NPV - Return on Investment - Payback Period.

UNIT V **9 Hours**

INTRODUCTION TO MACRO ECONOMICS AND FINANCIAL ACCOUNTING

National Income - Calculation Methods - Problems - Inflation - Deflation - Business Cycle - Taxes - Direct and Indirect Taxes - Fiscal and monetary policies.

Total: 45 Hours

Reference(s)

1. R. Kesavan, C. Elanchezhian, T. Sunder Selwyn, Engineering Economics and Financial Accounting, 1st Edition, Laxmi Publications, 2016.
2. V Mote, Samuel Paul, G. Gupta ,Managerial Economics Concepts and Cases, McGraw Hill Education, 1st Edition, New Delhi, 2017
3. K R Sharma, Corporate Financial Management, 1st Edition, Atlantic Publishers and Distributors (P) Ltd, 2023
4. S N Maheswari, Maheshwari Suneel K, Financial and Management Accounting, Sultan Chand and Sons, 1st Edition, 2022

21ME019 / 22MEM19 STATISTICAL PROCESS ANALYSIS AND OPTIMIZATION

3 0 0 3

Course Objectives

- To provide quality data from product measurements and process readings
- To study the usage of statistical approaches to regulate a process/ production method.
- To calculate both simple and multiple regression models.
- To introduce the basic principles and methods of statistical design of experiments.
- To qualify a new manufacturing process as being fit for use in production.

Programme Outcomes (POs)

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

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

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

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.

Course Outcomes (COs)

1. Apply statistical process control techniques to monitor and improve process quality by constructing and interpreting control charts, enabling real-time quality control and data-driven decision-making.
2. Assess the capability of manufacturing processes using appropriate statistical metrics and interpret process performance, for real-time analysis through relevant case studies.
3. Implement the regression analysis techniques including simple, multiple, and polynomial regression to model variable relationships, evaluate underlying assumptions, interpret ANOVA results, and assess model performance in real-world applications.
4. Design and analyze experiments using classical and Taguchi methods for single and multi-factor studies, interpret results statistically, and apply findings to real-world case studies for process optimization.
5. Develop response surface methodology to optimize processes using factorial, central composite, and Box-Behnken designs; analyze first-order response surfaces, and interpret results through case studies for process improvement.

Articulation Matrix

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

UNIT I **9 Hours**

STATISTICAL PROCESS CONTROL

Definition of quality and its evolution - Causes of variation in quality - Statistics and parameters - Variables and attributes - Frequency distribution - Histogram - Construction and interpretation - Use of software - Statistical basis of control chart - Anatomy of control charts - Selection and implementation of control charts - Control charts for variables and attributes - Simple case studies on applications of various types of control charts - Use of software.

UNIT II **9 Hours**

PROCESS CAPABILITY ANALYSIS

Process capability - Definition - Assumptions - Metrics - Methodology of process capability assessment - Case studies - Use of software.

UNIT III **9 Hours**

REGRESSION

Definition and need - Simple linear probabilistic model - Assumptions - Method of least squares - ANOVA for linear regression - Coefficient of determination - Multiple regression - General linear model and assumptions - ANOVA for multiple regression - Interpretation of results - Polynomial regression - Limitations of regression - Simple applications - Use of software.

UNIT IV **9 Hours**

EXPERIMENTAL DESIGN

Classical design of experiments - Single factor and multi-factor experiments - Analysis of experimental results - Taguchi design of experiments - Phases - Analysis and interpretation - Case studies - Use of software.

UNIT V **9 Hours**

RESPONSE SURFACE METHODOLOGY

Response surfaces - Two-level factorial designs - Addition of centre points - Method of steepest ascent - Central composite and Box-Behnken designs - Analysis of first order response surface - Case studies - Use of software.

Total: 45 Hours

Reference(s)

1. Grant E M and Leavenworth R L , "Statistical Quality Control", 7th Edition, Tata McGraw Hill, New Delhi, 2017
2. Douglas C. Montgomery , George C. Runger , "Probability and Statistics in Engineering", 6th Edition, Wiley, US, 2016
3. Myers R H, Montgomery D C and Anderson-Cook , "Response Surface Methodology, 4th edition, 2016
4. Process and Product Optimization using Designed Experiments", 4th Edition, Wiley, 2016.
5. Theodore T. Allen, " Introduction to Engineering Statistics and Lean Six Sigma: Statistical Quality Control and Design of Experiments and Systems", 2018

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.

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.

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

Course Outcomes (COs)

1. Apply the principles of steam power generation to explain the layout, components, and working of boilers and thermal power plants
2. Assess the function and integration of auxiliary systems such as fuel handling, ash handling, draught systems, condensers, and cooling towers in steam power plants.
3. Select appropriate components and layout for nuclear and hydel power plants by analyzing reactor types, turbine selection, and governing methods.
4. Analyze the configuration and operational characteristics of diesel and gas turbine power plants under various load and cycle conditions.
5. Investigate renewable power generation systems and compute the economics of energy production considering fixed, operating costs and load sharing.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO POWER PLANTS AND BOILERS

Layout of Steam power plant - Components, Selection. Steam Boilers and Cycles - High Pressure and Super Critical Boilers, Fluidized Bed Boilers. Combined Power Cycles. Comparison and Selection.

UNIT II **9 Hours**

STEAM POWER PLANT

Fuel and Ash Handling - Combustion Equipment for burning coal, Mechanical Stokers, Pulveriser, Electrostatic Precipitator, and Mechanical Collectors. Draught - different types. Surface Condenser types. Cooling Towers. Pollution controls.

UNIT III **9 Hours**

NUCLEAR AND HYDEL POWER PLANTS

Nuclear Energy - Fission, Fusion Reaction. Layout - Types of Reactors, Pressurized Water Reactor, Boiling Water Reactor, Waste Disposal and safety. Hydel Power Plant - Layout, Essential Elements, pumped storage. Selection of Turbines, Governing of Turbines.

UNIT IV **9 Hours**

DIESEL AND GAS TURBINE POWER PLANTS

Layout of Diesel power plant - Components, Selection of Engine Type, applications. Gas Turbine Power Plant - Layout, Fuels, Gas Turbine Material. Open and Closed Cycles - Reheating, Regeneration and Intercooling.

UNIT V **9 Hours**

OTHER POWER PLANTS AND ECONOMICS OF POWER PLANTS

Geo thermal power plant. Ocean thermal energy conversion (OTEC). Tidal power plant. Solar thermal power plant. Wind energy. Wind turbines. Magneto hydrodynamic generator (MHD). Cost of Electric Energy - Fixed and operating Costs, Economics of load sharing.

Total: 45 Hours

Reference(s)

1. S. C. Arora, S. Domkundwar, A course in Power Plant Engineering, Dhanpatrai & Sons, New Delhi, 2016.
2. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, New Delhi, 2019.
3. K.K.Ramalingam, Power Plant Engineering, Scitech Publications (India) Private Limited, 2015.
4. P. K. Nag, Power plant Engineering, Tata McGraw Hill Company Private Limited, New Delhi, 2017.
5. G. D. Rai, Introduction to Power Plant Technology, Khanna Publishers, New Delhi, 2013.
6. R. K. Rajput, Power Plant Engineering, Laxmi Publications, New Delhi, 2016.
7. https://archive.nptel.ac.in/courses/112/107/112107291/

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.

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.

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

Course Outcomes (COs)

1. Apply the first and second laws of thermodynamics to evaluate the performance of refrigeration cycles and systems including reversed Carnot, Bell-Coleman, and vapour compression cycles.
2. Analyze the functional characteristics and performance of key refrigeration components (compressors, evaporators, condensers, and expansion valves) and determine the suitability of refrigerants based on environmental impact and system requirements.
3. Select the suitable refrigeration systems for specific applications by identifying the appropriate method of cooling, such as vapour compression, vapour absorption, thermo-electric, or cascade systems.
4. Formulate air conditioning solutions based on psychrometric analysis and cooling/heating load calculations for different environmental and building comfort conditions.
5. Develop and integrate installation, servicing, and safety protocols for various air conditioning systems, including industrial and automobile applications, based on user needs and operational constraints.

Articulation Matrix

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

UNIT I **9 Hours**

BASIC PRINCIPLE, CYCLES AND SYSTEMS

First and Second law of thermodynamics applied to refrigerating machines - Reversed Carnot cycle, unit of refrigeration, co-efficient of performance. Air refrigeration: Bell-Coleman cycle, Types of air refrigeration systems. Need for modification of Carnot cycle, Ideal and actual vapour compression cycle, Improvements in simple vapour compression system.

UNIT II **9 Hours**

COMPONENTS OF REFRIGERATION SYSTEM

Types, and Working-Compressors, Evaporator, Condenser, Expansion Valve. Air conditioning systems and their types, selection of system, Components and controls of air distribution. Refrigerants - Types, Desirable properties and Nomenclature of refrigerants, Impact of refrigerants, recent substitutes for refrigerants.

UNIT III **9 Hours**

REFRIGERATION SYSTEM

General Layout, Working Principle- Vapour Compression Refrigeration system - Vapour absorption refrigeration system (Li-Br, Aqua Ammonia and solar) - Thermo-electric refrigeration system, Electrolux refrigeration system, Vortex refrigeration system, Steam jet refrigeration system and Cascade refrigeration system.

UNIT IV **9 Hours**

PSYCHROMETRIC AND AIR CONDITIONING SYSTEMS

Principle and properties of psychometric of air, Representation of various psychometric processes on psychometric chart and their analysis. Comfort Air Conditioning-parameters, requirements, concept of effective temperature, infiltration, internal heat gains, comfort charts. Window air conditioner, split air conditioner, Central air conditioner, Cooling and heating load calculations.

UNIT V **9 Hours**

INSTALLATION, SERVICING AND APPLICATIONS

Window AC and Split AC-installation Procedure, Charging methods, Leakage detection methods-Servicing and Safety Procedure. Importance, General layout, Working and limitations- Industrial Air conditioner-Food storage and preservation system-Ice manufacturing plant-Solar Air conditioner-Automobile air conditioner.

Total: 45 Hours

Reference(s)

1. C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2017.
2. Langley and C. Billy, Refrigeration and Air conditioning, Ed. 3, Engle wood Cliffs (NJ), Prentice Hall of India, New Delhi, 2009
3. Roy J. Dossat, Principles of Refrigeration, Pearson Education, New Delhi, 2007
4. N. F Stoecker and Jones, Refrigeration and Air Conditioning, Tata McGraw Hill Publishing Company, New Delhi, 2008
5. Manohar Prasad, Refrigeration and Air Conditioning, Wiley Eastern Limited, 2007
6. Dossat, R.J. Principles of Refrigeration system,Prentice Hall, 2013.
7. https://archive.nptel.ac.in/courses/112/105/112105129/

21ME022 / 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.

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

Course Outcomes (COs)

1. Apply the principles of energy forms, sources, and conversion techniques to basic thermal, mechanical, and electrical systems including electricity tariffs.
2. Assess the scope and methodology of energy audits and energy management systems to implement efficiency measures and analyze cost-effective solutions.
3. Compare the performance of thermal utilities such as steam systems, boilers, and furnaces to identify energy losses and opportunities for conservation.
4. Analyze the efficiency of electrical systems including motors, compressors, and lighting to detect losses and propose improvement strategies.
5. Investigate energy generation and consumption patterns in thermal power stations, steel, cement, and textile industries to recommend performance improvement measures.

Articulation Matrix

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

UNIT I **9 Hours**

VARIOUS FORMS AND CONSERVATION OF ENERGY

Energy sources, classification: Electricity basics- DC, AC current, electricity tariff, Thermal Basics- thermal energy contents of fuel, Mechanical, electrical and thermal energy conversion techniques: energy conversion efficiencies.

UNIT II **9 Hours**

ENERGY MANAGEMENT

Scope, types of energy audit, energy audit methodology, role of energy managers; Energy management system (EnMS): ISO standards, implementing energy efficiency measures, detailed, project report, energy monitoring and targeting, economic and cost benefit analysis, energy service companies (ESCOS).

UNIT III **9 Hours**

ENERGY EFFICIENCY IN THERMAL UTILITIES

Steam engineering in thermal and cogeneration plants; efficient utilization of steam: Piping, traps, flashing, condensate recovery, pinch analysis; Boiler: Losses and efficiency calculation methods, controls; Furnaces: Heat balance and efficiency calculations, energy conservation opportunities, insulation and refractories

UNIT IV **9 Hours**

ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

Electrical system efficiency improvements: Motor, diesel generator, centrifugal pumps, fans, blowers, lighting systems; Air compressor: Line loss, leakage test, optimum pressure.

UNIT V **9 Hours**

PERFORMANCE ASSESSMENT

Industrial case studies: Assessment of energy generation/consumption in thermal station, steel industry, cement industry, textile industry.

Total: 45 Hours

Reference(s)

1. Alan P R, Beth P J , Energy Management and Efficiency for the Process Industries, Wiley Publications, 2015.
2. Abbi Y P, Shashank , "Handbook on Energy Audit and Environment Management.
3. The Energy and Resources Institute, 2009. Donald R Wulfinghoff, Energy Efficiency Manual, Energy Institute Press, 2011.
4. Bureau of Energy Efficiency, Energy Manager Training Manual, Government of India, 2015.
5. W. F. Kenny, Energy Conservation In Process Industry.
6. Amlan Chakrabarti, Energy Engineering and Management, Prentice hall India 2011.
7. https://archive.nptel.ac.in/courses/112/105/112105221/

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.

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

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

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

Course Outcomes (COs)

1. Apply the principles of compressible flow and conservation equations to determine flow regimes, Mach number, and stagnation properties under varying flow conditions.
2. Analyze the effects of area variation in isentropic flow through ducts and interpret the influence of choking and Mach number on mass flow rate and impulse function.
3. Investigate the flow behavior and property variations in constant area ducts subjected to friction (Fanno flow) and heat addition (Rayleigh flow) using graphical and analytical methods.
4. Interpret the governing equations and flow property changes across normal shock waves, and assess shock implications in nozzles using the Prandtl and Rankine-Hugoniot relations.
5. Select appropriate propulsion systems and propellants based on performance criteria such as thrust, specific impulse, and application suitability.

Articulation Matrix

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

UNIT I **9 Hours**

COMPRESSIBLE FLOW FUNDAMENTALS

Introduction to compressible flow - Integral and differential forms of conservation equations, velocity of sound, Mach number, various regimes of flow, wave propagation, Mach cone and Mach angle- Stagnation state - stagnation enthalpy, stagnation temperature, stagnation pressure and stagnation density - critical state - reference velocities, reference Mach number. Effect of Mach number on compressibility.

UNIT II **9 Hours**

FLOW THROUGH VARIABLE AREA DUCTS

Isentropic flow through variable area ducts - effect of area change on flow parameters, area ratio as a function of Mach number, impulse function, mass flow rate equations, chocking flow.

UNIT III **9 Hours**

FLOW THROUGH CONSTANT AREA DUCTS

Flow in constant area ducts with friction (Fanno flow) Governing equations, fanno curves and Fanno flow equations, variation of flow properties, variation of Mach number with duct length. Flow in constant area ducts with simple stagnation temperature change (Rayleigh Flow) - Governing equations, Rayleigh line and Rayleigh flow equation, maximum heat transfer in Rayleigh flow.

UNIT IV **9 Hours**

FLOW WITH NORMAL SHOCK

Governing equations - variation of flow properties like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock - Prandtl equation - Rankine Hugonoit equation. Impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with normal shock.

UNIT V **9 Hours**

AIRCRAFT AND ROCKET PROPULSION

Aircraft propulsion - types of jet engines, energy flow through jet engines. Performance of turbo jet engines - thrust, thrust power, propulsive and overall efficiencies - thrust augmentation in turbo jet engine. Ram jet, Scram jet and Pulse jet engines. Rocket Propulsion - Classification of rocket engines. Propellants - solid, liquid and hybrid propellants, rocket engines thrust equation, effective jet velocity, specific impulse. Rocket engine performance.

Total: 45 Hours

Reference(s)

1. Patrick H. Oosthuizen and William E. Carscallen, Introduction to Compressible Fluid Flow, 2nd edition, CRC Press, Taylor & Francis Group, Florida, 2013.
2. Robert D. Zucker, Fundamentals of Gas Dynamics, 2nd edition, John Wiley & Sons Inc., New York, 2002.
3. H.I.H. Saravanamuttoo, G.F.C. Rogers, H. Cohen and P.V. Straznicky, Gas Turbine Theory, 7th edition, Pearson Education, 2017.
4. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, 9th edition, John Wiley & Sons Inc., New York, 2017.
5. S. M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th edition, New Age International private Limited, 2014.
6. https://archive.nptel.ac.in/courses/112/106/112106166/

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.

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the principles of solar radiation and thermal conversion to examine various solar collectors and solar thermal applications including desalination, drying, and power generation.
2. Analyze the performance of solar photovoltaic systems by applying photovoltaic principles, and interpret I-V characteristics, module configurations, and maximum power point tracking techniques.
3. Illustrate the principles, technologies, and site selection criteria of wind and bio energy systems for efficient energy conversion and sustainable applications.
4. Investigate the working methodologies, resource potential, and technological devices of ocean energy and geothermal systems for effective energy harnessing.
5. Develop hydrogen-based energy systems and fuel cell technologies to support clean and sustainable energy applications.

Articulation Matrix

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

UNIT I **9 Hours**

SOLAR THERMAL SYSTEMS

Solar radiation, Radiation measurement, Introduction to solar collectors, Flat Plate collectors, evacuated tube collectors and concentrating collectors and Air heaters, Solar desalination systems, Solar drying systems, Solar thermal systems for power generation.

UNIT II **9 Hours**

SOLAR PHOTOVOLTAIC SYSTEMS

Solar Photovoltaic systems: Basic Principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications.

UNIT III **9 Hours**

WIND ENERGY AND BIO ENERGY

Basic principles of wind energy conversion - classification of wind turbines, wind power generation curves, wind data and energy estimation. Site selection considerations. Bio mass resources, Energy from Bio mass, Biofuels classification, Biomass gasification- Technologies for utilisation of biomass, Biogas - Production, factors affecting biogas production, biogas plants, Bio mass Cogeneration.

UNIT IV **9 Hours**

OCEAN THERMAL ENERGY AND GEOTHERMAL ENERGY

Wave energy - Energy from waves, energy potential, conversion devices. Tidal energy - energy potential, conversion systems. Ocean thermal energy conversion systems. Geothermal energy - geothermal resources, geothermal conversion systems.

UNIT V **9 Hours**

HYDROGEN AND FUEL CELLS

Basic properties of hydrogen. Technologies of hydrogen production. Transformation of hydrogen energy - hydrogen economy. Fuel cells - operating principle, classifications, Specific characteristics, and applications.

Total: 45 Hours

Reference(s)

1. Bhatia, S. C., and Gupta, R. K., Textbook of Renewable Energy, India, Woodhead Publishing India PVT. Limited, 2018.
2. Twidell, John, and Weir, Anthony D., Renewable Energy Resources, United Kingdom, Taylor & Francis, 2006.
3. Nelson, Vaughn., Introduction to Renewable Energy, United Kingdom, CRC Press, 2011.
4. Cengel, Yunus A., Fundamentals and Applications of Renewable Energy, United States, McGraw Hill LLC, 2019.
5. Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017.
6. https://nptel.ac.in/courses/103103206

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.

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

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

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

Course Outcomes (COs)

1. Apply the fundamental equations of fluid dynamics, including the Navier–Stokes equations, and classify partial differential equations to establish a foundation for solving fluid flow problems.
2. Apply finite difference techniques to discretize and solve governing equations for fluid flow and analyze the stability, convergence, and accuracy of numerical methods for various flow regimes.
3. Analyze the finite volume method to discretize and solve one-dimensional and two-dimensional fluid flow problems, and analyze pressure-velocity coupling for steady-state flows.
4. Apply weighted residual and variational approaches of finite element method to solve steady-state heat conduction and incompressible flow problems in one-dimensional and two-dimensional domains.
5. Develop structured and unstructured computational grids using algebraic and differential grid generation techniques, and implement body-fitted coordinate methods to model complex geometries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO CFD

Introduction - Applications and impact of CFD in diverse fields - Naiver Stroke equations in fluid dynamics-continuity-momentum and energy-generic integral form for governing equations -Initial and Boundary conditions. Classification of partial differential equations-Elliptic, Parabolic and Hyperbolic types.

UNIT II **9 Hours**

FINITE DIFFERENCE METHOD

Basics and discretization of simple and complex governing equations. Applications. Incompressible in-viscid Flows- Illustrative and physical examples of Elliptic, Parabolic and Hyperbolic equations - Discretization of partial Differential Equations. Implicit, explicit and Crank Nicolson finite difference methods for viscous flows. Stability, convergence, accuracy.

UNIT III **9 Hours**

FINITE VOLUME METHOD

Basic rules for FV Discretization. Finite Volume (FV) Discretization of one and two dimensional steady state diffusion type problems - 1-D convection-diffusion type problem - Unsteady flows - implementation of boundary conditions in Finite Volume. Solution of discretized equations. Solution algorithm for Pressure Velocity coupling in steady flows - Pressure-velocity coupling - SIMPLE scheme.

UNIT IV **9 Hours**

FINITE ELEMENT METHOD IN FLUIDS

Over view of Finite Element Techniques in Computational Fluid Dynamics. Weighted residual and Variational formulations. Finite element interpolation. One and two dimensional elements. Steady state conduction and incompressible potential flow problems.

UNIT V **9 Hours**

NUMERICAL GRID GENERATION AND TURBULENCE MODEL

Introduction. Algebraic grid generation. Differential Grid Generation. Structured and unstructured grids. Body fitted Coordinate Method. Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

Total: 45 Hours

Reference(s)

1. J. D. Anderson., Jr. Computational Fluid Dynamics- The Basic with Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
2. S. C. Gupta, Applied Computational Fluid Dynamics, Wiley India Pvt. Ltd., New Delhi, 2019.
3. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York, 2004.
4. H. K. Versteeg and W. Malalasakera, An Introduction to Computational Fluid Dynamics The Finite Volume Method, Pearson Education Ltd., New Delhi, 2007.
5. K. A. Hoffman, Computational Fluid Dynamics for Engineering, Engineering Education System, Austin, Texas 2005.
6. http://nptel.ac.in/courses/112105045/

21ME026 / 21MEH26 TOOL AND DIE DESIGN 3 0 0 3

Course Objectives

- To provide knowledge on design principles for designing the jigs and fixtures.
- To impart knowledge on locating and clamping principles for designing jigs and fixtures.
- To introduce the different types of jigs for producing the part.
- To study different types of fixtures for the producing the part.
- To introduce about press working terminologies and press accessories.

Programme Outcomes (POs)

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

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

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

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

Course Outcomes (COs)

1. Apply principles of tool design for jigs and fixtures, by following limits, fits, and geometric tolerances to ensure precision in manufacturing tools
2. Demonstrate location and clamping principles to design effective jigs and fixtures using various clamping methods for improved manufacturing accuracy and efficiency
3. Design jigs by selecting appropriate elements, drill bushes, and mechanisms to meet production and operational requirements for specified components
4. Develop fixture designs for machining and inspection processes by integrating general principles and selecting suitable types for specific component operations
5. Analyze and design press tools including dies, punches, and press accessories for bending, forming, and drawing operations, considering factors like spring-back and tonnage calculations.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO TOOL DESIGN

Objectives, Challenges and Requirements, Production and Inspection Devices. Jigs and Fixtures - Differences, Design principles, Advantages, Essential Features, Materials used. Introduction to Limits, Fits and Tolerances, International Tolerance Grades, Geometric Dimensioning and Telebanking in tools.

UNIT II **9 Hours**

LOCATION AND CLAMPING

Location - Principles, Basic rules, Degrees of Freedom, 3-2-1 Principle, Locating Methods, Types of Locators, Standard Parts. Clamping - Principles, Types of Mechanical Actuation Clamps, Pneumatic, Hydraulic, Magnetic, Vacuum, Electrostatic clamping, Epoxy Resin Clamping. Factors considered for Design of Jigs and Fixtures.

UNIT III **9 Hours**

DESIGN OF JIGS

Jigs - Elements, Construction, Types and Materials for Jig Elements. Drill bushes - Types, Special Bushes, Bush Clearance. Automatic drill jig, Rack and pinion operated, Indexing, Air operated Jig components - Design of Jigs for given components.

UNIT IV **9 Hours**

DESIGN OF FIXTURES

General Design Principles of Fixture. Types of Boring, Lathe, Milling and Broaching fixtures - Setting Block. Grinding, Planing and Shaping fixtures. Inspection - Gauging, Measuring and Supplement fixtures. Welding, Assembly and Modular fixtures. Design of fixtures for given component.

UNIT V **9 Hours**

DESIGN OF PRESS TOOLS

Mechanical Presses - Working terminology, Elements, Types and Press Accessories. Types of Dies, Punches and Strippers. Pressure pad, Knockouts, Stops and Pilots. Bending, Forming, Drawing and Deep Drawing - Dies and its Types. Spring-back phenomenon and Draw Ratio. Progressive, Combination and Compound Dies. Design and Development of Dies - Blank Development, Strip Layout, Computation of capacities and tonnage requirements.

Total: 45 Hours

Reference(s)

1. Edward G. Hoffman, Jig and Fixture Design, Cengage Learning, New Delhi, 2004
2. C. Elanchezhian, Design of Jigs, Fixtures and Press Tools, Eswar Press, Chennai, 2010
3. P. H. Joshi, Jigs & Fixtures, Tata McGraw Hill Education Private Limited, New Delhi 2012
4. Hiram E Grant, Jigs and Fixtures, Tata McGraw Hill Education Private Limited, New Delhi, 2011
5. C. Donaldson, G. H. Lecain and V. C. Goold, Tool Design, Tata McGraw Hill Education Private Limited, New Delhi, 2011
6. Fred Herbert Colvin, Lucian Levant Hass, Jigs and Fixtures: A Reference Book Showing Many Types of Jigs and Fixtures in Actual Use, and Suggestions for Various Cases, Nabu Press, 2011

21ME027 / 21MEH27 GEOMETRIC MODELLING 3 0 0 3

Course Objectives

- To provide the knowledge on coordinate systems.
- To study the mathematical modelling of analytical and synthetic curves.
- To learn the parametric and non- parametric forms of analytical and synthetic surfaces.
- To impart the knowledge about solid modelling techniques.
- To learn the transformation and projection techniques.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the principles of geometric and display coordinate systems to support 3D modelling and visualization.
2. Formulate analytical and synthetic curve models using parametric and non-parametric representations to understand curve generation and modification in geometric modelling.
3. Develop analytical and synthetic surface models using parametric and non-parametric forms to understand surface generation and transformation techniques in geometric modelling.
4. Analyze the solid modelling techniques to create and manipulate solid models with defined geometric properties.
5. Demonstrate the 2D and 3D transformation and projection techniques to visualize geometric models through orthographic and perspective projections.

Articulation Matrix

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

UNIT I **9 Hours**

COORDINATE SYSTEMS

Geometric co-ordinate systems - Cartesian, Cylindrical and Spherical coordinate systems. Display co-ordinate systems - Global, Local, View and Screen coordinate systems.

UNIT II **9 Hours**

MATHEMATICAL MODELLING OF CURVES

Definition - Parametric and non-parametric forms of analytical and synthetic curves. Analytical Curve modelling - Line Segment, Circle, Ellipse. Synthetic Curve modelling - Hermite Cubic Spline, Bezier, B-spline and Rational Curves. Curve manipulation techniques.

UNIT III **9 Hours**

MATHEMATICAL MODELLING OF SURFACES

Definition - Parametric and non- parametric forms of analytical and synthetic surfaces. Analytical surface modelling - Parametric form of plane, loft, Cylindrical, Surface of revolution. Synthetic Surface modelling - Hermite Bicubic Spline, Bezier, B-spline, Coon"s, triangular, blending Surfaces. Surface Manipulation techniques.

UNIT IV **9 Hours**

MATHEMATICAL MODELLING OF SOLIDS

Properties of solid model, solid modelling Techniques - Boundary representation, Constructive Solid Geometry, Analytical Solid Modelling, Sweep representation schemes. Solid Manipulation Techniques.

UNIT V **9 Hours**

TRANSFORMATION AND PROJECTION TECHNIQUES

Introduction to computer graphics, Non-interactive Vs interactive computer graphics, applications, graphics system configuration. 2D and 3D transformation techniques - Translation, Rotation, Scaling and Reflection principles. Principle of concatenated transformation. Orthographic and Perspective Projections of Geometric Models.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Education (P) Ltd., Special Indian Edition, 2014.
2. Amarendra N Sinha and Arun D Udai, Computer Graphics, Second reprint, Tata McGraw Hill Education (P) Ltd., 2014.
3. Michael E. Mortenson, Geometric Modeling, Third edition, Industrial Press, 2006.
4. Rogers, Mathematical Elements for computer Graphics, Tata Mcgraw Hill Education Private Limited, 2009.
5. Rajiv Chopra, Computer Graphics: A Practical Approach, Concepts, Principles, Case Studies, First Edition, S-Chand and Company Ltd., 2011.

21ME028 / 21MEH28 ERGONOMICS 3 0 0 3

Course Objectives

- To learn the importance of ergonomics approach in product design and development.
- To study the human information input and workstations to fit employees
- To develop appropriate control measures for ergonomics risk factors
- To explore the workplace according to good ergonomics principles
- To assess ergonomics aspects of the working environment and work organisation

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Analyze the human-machine systems, system reliability, and the stages of conceptual to detailed design in manual, mechanical, and automated environments to explain the multidisciplinary approach to human factors engineering.
2. Investigate various modes of information input and processing, including text, graphics, symbols, codes, and multi-sensory displays to optimize human-system interaction.
3. Assess human physical output and control mechanisms to enhance system performance and user safety.
4. Apply ergonomic principles and anthropometric data to design workspaces, seating, component layout, and manual tasks that reduce fatigue, enhance work capacity, and improve comfort and interpersonal efficiency in the workplace.
5. Integrate the impact of environmental conditions and human factors on performance, safety, and system design by analyzing variables in accordance with ISO/DIS 6385 and OSHA guidelines.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO HUMAN FACTORS ENGINEERING

Definition - human technological system - multidisciplinary engineering approach - human - machine system - manual - mechanical - automated system - human system reliability conceptual design - advanced development - detailed design and development

UNIT II **9 Hours**

INFORMATION INPUT

Input and processing - text - graphics - symbols - codes - visual display of dynamic information - auditory - tactual - olfactory displays - speech communications.

UNIT III **9 Hours**

HUMAN OUTPUT AND CONTROL

Physical work - manual material handling - motor skill - human control of systems - controls and data entry devices - hand tools and devices.

UNIT IV **9 Hours**

WORKPLACE DESIGN

Applied anthropometry - workspace design and seating - arrangement of components within a physical space - interpersonal aspects of work place design - design of repetitive task - design of manual handling task - work capacity - stress - and fatigue.

UNIT V **9 Hours**

ENVIRONMENTAL CONDITIONS AND HUMAN FACTORS APPLICATIONS

Illumination - climate - noise - motion - sound - vibration - colour and aesthetic concepts. Human error - accidents - human factors and the automobile - organizational and social aspects - steps according to ISO/DIS6385 - OSHA""s approach - virtual environments.

Total: 45 Hours

Reference(s)

1. Chandler Allen Phillips, "Human Factors Engineering", John Wiley and Sons, 2000
2. Mark S Sanders, "Human Factors in Engineering and Design", McGraw Hill, 1993.
3. Bridger R S , "Introduction to Ergonomics", Taylor and Francis, 2003.
4. Mayall W H , "Industrial Design for Engineers", London ILIFFE Books Ltd., 1998.
5. Martin Helander , "A Guide to Human Factors and Ergonomics", 2nd Edition, CRC Press, 2005.
6. Mark Lehto, Steven J. Landry , "Introduction to Human Factors and Ergonomics for Engineers", 2nd Edition, CRC Press, 2012.

21ME029 / 21MEH29 PRODUCT DATA AND LIFE CYCLE MANAGEMENT **3 0 0 3**

Course Objectives

- To understand the exposure on the internet based technology for the implementation of product life cycle concepts in product development.
- To familiarize the concepts, functions and administration features of Product Data Management.
- To educate the features of product life cycle management involved to resolve the problems while automating product dependent business processes
- To provide exposure on implementation of visualization and virtual reality approach and its techniques in product development
- To explore the diverse ways of integrating PLM with other CAD & ERP software for product development

Programme Outcomes (POs)

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

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

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

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

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

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

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

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

Course Outcomes (COs)

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

Articulation Matrix

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

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 / 21MEH30 PRODUCT DEVELOPMENT AND REVERSE ENGINEERING **3 0 0 3**

Course Objectives

- To develop a new product by practicing a typical NPD Process followed in Industry
- To learn value engineering and product design tools to design a product
- To perform the Engineering Change Management process for a product
- To familiarize with the concept and design guidelines for manufacturing parts by different machining processes
- To educate the emerging trends and applications of reverse engineering and Additive manufacturing technology

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Illustrate the product development cycle and evaluate strategies such as idea screening, concept testing, and commercialization using product life cycle management tools.
2. Apply value engineering techniques and product design tools like QFD, DFA, DFM, and ergonomic principles to improve design efficiency and cost-effectiveness.
3. Participate in the Engineering Change Management process and analyze the roles, impacts, and documentation (ECR, ECN, ECO) in product data workflows.
4. Apply DFMA and DFE guidelines to design sustainable, recyclable, and regulation-compliant products considering various manufacturing processes.
5. Utilize reverse engineering tools (CMM, laser scanner, CT, MRI) and STL software for point cloud processing and demonstrate applications of additive manufacturing across industries.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO NEW PRODUCT DEVELOPMENT

Product life cycle, Product policy of an organization. Selection of a profitable product, Product design process, new product strategy Idea generation and screening Concept development and testing Business analysis Product development testing and analysis Commercialization Collaboration Gantt chart product life cycle management.

UNIT II **9 Hours**

VALUE ENGINEERING AND PRODUCT DESIGN TOOLS

Value engineering in product design, Advantages, Applications in product design. Introduction to product design tools, QFD, Computer Aided Design, Robust design, DFX, DFM, DFA, Ergonomics in product design.

UNIT III **9 Hours**

ENGINEERING CHANGE MANAGEMENT

Product Data Management, Engineering Change Management Process Impact of ECM, Typical steps followed, Different roles in an ECM Process, Participating in an ECM process, Engineering Change Request, Engineering Change Notice, Engineering Change Orders.

UNIT IV **9 Hours**

DFMA GUIDELINES

Product design for manual assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection molding etc. Design for Environment (DFE) methods, Design guide lines, Lifecycle assessment, Design to minimize material usage, Design for disassembly, Recyclability, Remanufacture, Energy efficiency, Design to regulations and standards.

UNIT V **9 Hours**

REVERSE ENGINEERING AND APPLICATIONS OF ADDITIVE MANUFACTURING

Reverse Engineering, Application of CMM, Laser scanner, CT and MRI scan in acquiring point data, Software for STL file processing. Application of Rapid prototyping in medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries. Leading manufacturer of RP Systems.

Total: 45 Hours

Reference(s)

1. T. Karl, Ulrich and D. Steven, and Eppinger, Product Design and Development, Mcgraw Hill 2009
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973.
3. Robert Matousek, Engineering Design A Systematic Approach, Blackie and Son Limited, London, 1974.
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.
6. https://nptel.ac.in/courses/112107217/

21ME031 / 21MEH31 DESIGN FOR MANUFACTURING AND ASSEMBLY

3 0 0 3

Course Objectives

- To learn the way of specifying geometric dimensioning and tolerancing in engineering drawing
- To familiarize the design considerations for designing components for the casting, welding and forming processes
- To familiarize the design guidelines while designing components which are manufacturing by different machining processes
- To learn the factors affecting easy assembly of parts into a final product
- To impart knowledge about the product life cycle assessments and environmental impact of materials, manufacturing methods and the way to minimize it

Programme Outcomes (POs)

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

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

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

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

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

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

PSO1.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 geometric dimensioning and tolerance features to determine their influence on functional dimensions and overall assembly precision.
2. Design cast, welded, and formed components by applying manufacturing design principles to minimize defects and ensure production feasibility.
3. Implement design for manufacture and assembly (DFM & DFA) strategies to enhance machining efficiency and assembly effectiveness.
4. Apply design for assembly (DFA) principles to reduce part count and handling time, thereby increasing assembly efficiency.
5. Formulate eco-friendly design strategies by incorporating lifecycle assessment and sustainability practices in product development.

Articulation Matrix

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

UNIT I **10 Hours**

GEOMETRIC DIMENSIONING AND TOLERANCING

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. Geometric Dimensioning and Tolerancing - Location, Form, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours**

DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, parting line - Redesign of castings based on parting line considerations, Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components

UNIT III **8 Hours**

DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS

Design for Manufacture Guidelines - Design features to facilitate machining - Drills - Milling cutters -Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area Simplification by separation - Simplification by amalgamation. Design for Manufacture: Machinability, Economy, Clamp ability, Accessibility, Assembly. Redesign for Manufacture -Examples.

UNIT IV **8 Hours**

DESIGN FOR ASSEMBLY

Design for Assembly (DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours**

DESIGN FOR ENVIRONMENT

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&T''s (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards.

Total: 45 Hours

Reference(s)

1. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design,McGraw-Hill Professional, New Delhi, 2011
2. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 1973
3. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 1974
4. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 2007.
5. J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw-Hill Publications, New Delhi, 2000
6. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 2003.

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. Apply appropriate automation technologies for specific industrial sectors by examining and selecting the optimal system.
2. Develop PLC programs using various programming techniques, including programming languages and logical instructions.
3. Configure a SCADA system to monitor and control industrial processes, demonstrating the ability to implement its functionalities and tools effectively.
4. Analyze the security of a Distributed Control System (DCS) against potential threats, identifying vulnerabilities and areas of improvement.
5. Evaluate the effectiveness of security measures in safeguarding communication systems, assessing their capability to protect against potential cyber threats.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF AUTOMATION

Automation in Production System-Principles and Strategies of Automation-Basic Elements of an Automated System-Advanced Automation Functions-Levels of Automation-Flow lines, Transfer Mechanisms-Fundamentals and Analysis of Transfer Lines, Fundamentals of IoT

UNIT II **9 Hours**

PROGRAMMABLE LOGIC CONTROLLER

PLC Architecture - Processor Memory Organization: Program Files, Data Files- Programming Languages- Wiring Diagrams and Ladder Logic Programs- Instructions: Simple Instructions, Timer, Counter, Program Control, Data Manipulation, Math Instructions - Selection of PLC

UNIT III **9 Hours**

SUPERVISORY CONTROL AND DATA ACQUISITION

Elements of SCADA-Functionalities of SCADA-Architecture: Hardware, Software: Development, Runtime mode functions-Tools: Tag Database-Recipe database- Alarm Logging-Trends: Real Time, Historical Trends-Security and User Access Management-Management Information System-Report Function.

UNIT IV **9 Hours**

DISTRIBUTED CONTROL SYSTEM

Evolution of DCS - Types of Architecture - Local Control Unit - Communication Facilities - Operator and Engineering Interfaces - Operator Displays - Process Interfacing issues.

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction - Communication Hierarchy, Communication System Requirements - Network Topologies - Communication Modes HART Networks and OSI models- Communication buses -Fieldbus, Modbus, Profibus - Device net - CAN network - System Operation and Troubleshooting.

Total: 45 Hours

Reference(s)

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Fourth Edition, Pearson Education, UK, 2016
2. Webb J.W, Programmable Controller Principles and applications, Fifth Edition, Morrill Publishing Co, USA, 2016
3. Petruzella, FD, Programmable Logic Controllers, Fifth Edition, McGraw-Hill, New York, 2016.
4. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition, Fourth Edition, ISA Publication, Europe, 2009
5. Lucas M.P, Distributed control systems, Van Nostrand Reinhold Company, Newyork, 1986

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. Differentiate between types of robot manipulators, classify robot configurations, and analyze end-effector mechanisms for selecting suitable robots in industrial applications.
2. Apply kinematic principles such as coordinate transformations, Euler angles, and Denavit–Hartenberg convention to demonstrate forward and inverse kinematics of robotic manipulators.
3. Analyze velocity and static force relationships of robotic manipulators using Jacobians, and evaluate singularities to determine manipulator workspace limitations.
4. Develop and compute dynamic equations of robotic systems using Lagrangian mechanics, and plan suitable point-to-point and continuous trajectory paths for motion control.
5. Investigate mobile robot kinematics and localization techniques by applying predictive modeling, Kalman filters, Bayesian estimation, and demonstrating programming skills using ROS.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	-	2	1	-	-	-	-	-	-	-	1	-
2	3	2	2	-	2	1	-	-	-	-	-	-	-	3	-
3	3	2	1	-	3	1	-	-	-	-	-	-	-	3	-
4	3	1	1	-	2	1	-	-	-	-	-	-	-	3	-
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 / 21MEH05 AUTOMATION SYSTEM DESIGN 3 0 0 3

Course Objectives

- To understand the need for automation across a range of industrial sectors.
- To explain the principles of motion components.
- To study about the technological advancements in transfer lines and automated assembly area.
- To explain the design procedure in automation and comprehend the CIROS software''s system integration process.

Programme Outcomes (POs)

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

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

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

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

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

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. Illustrate the fundamentals of process automation and modeling of electromechanical systems using the bond graph technique.
2. Apply engineering principles to select suitable motion components (motors, guides, ball screws) based on inertia calculations and application requirements.
3. Analyze automated assembly lines using takt time, buffer design, and flow line balancing to improve manufacturing efficiency.
4. Design products suitable for high-speed automatic feeding, orienting, and insertion based on established automation rules.
5. Simulate and evaluate automation system designs using CIROS software and assess the economic feasibility of implementation.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUCTION TO PROCESS AUTOMATION

Process Automation-paper industry, packaging industry, food processing industry, Integrated design issues in automation systems, Mechatronics design process-benefits, modelling of electromechanical systems, bond graph technique, Automation migration strategy-building blocks of automation systems.

UNIT II **11 Hours**

SELECTION OF MOTION COMPONENTS

Selection of motor for automation system, Calculation of inertia force for motor, LM Guide ways, Ball screws, Selection from the manufacturers catalogue based on the applications.

UNIT III **9 Hours**

TRANSFER LINES AND AUTOMATED ASSEMBLY

General terminology-takt time, setup time and cycle time, Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines-modular fixturing-Flow line balancing.

UNIT IV **10 Hours**

DESIGN FOR HIGH-SPEED AUTOMATIC ASSEMBLY

Introduction, Design of parts for high-speed feeding and orienting, high speed automatic insertion, Analysis of an assembly, General rules for product design for automation-Application of high-speed automatic assembly.

UNIT V **7 Hours**

SYSTEM INTEGRATION

Issues and systematic approaches, design and simulation using CIROS software, Economics of automation systems design and implementation.

Total: 45 Hours

Reference(s)

1. Mikell P Groove, "Automation Production Systems and Computer Integrated Manufacturing", Pearson education, New Delhi,
2. Geoffery Boothroyd, "Assembly Automation and Product Design", CRC Press, USA, 2016.
3. DevadasShetty , "Mechatronics System Design", PWS Publishing Company, USA, 2010.
4. Wilfried Voss, "A Comprehensible Guide to Servo Motor Sizing", Copperhill Technologies Corporation, Massachusetts, 2007.

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.

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. Apply fundamental principles to choose appropriate material handling systems ensuring safety and operational efficiency
2. Analyze the suitability of various hoists and winches for specific industrial applications
3. Compare the functionality of different conveyors and elevators to select optimal systems for defined working environments
4. Investigate appropriate lifting mechanisms to enhance material handling performance in diverse settings.
5. Design safe and efficient material handling systems tailored to specific workplace requirements..

Articulation Matrix

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

UNIT I **9 Hours**

MATERIALS HANDLING EQUIPMENT

Importance and principles of material handling. Types of intraplant transport facility and applications. Choice of material handling equipment - Surface and overhead equipment - general characteristics of surface and overhead equipment - AGV- AS/RS

UNIT II **9 Hours**

HOIST AND WINCHES

Basic Principles - Types of Cranes - Jib Cranes - Overhead Travelling Cranes/Bridge Cranes - Gantry Cranes - Wharf Cranes - Pillar Cranes - Tower Cranes - Truck and Wagon Cranes - Crawler Cranes - Railroad/Locomotive Cranes - Floating Cranes - Derricks. Storing equipment like pallets, bins, racks, decking, order picking, positioning equipment.

UNIT III **9 Hours**

CONVEYORS AND ELEVATORS

Belt Conveyors - Definition, General Characteristics, Types, Parts, Design Aspects, Pneumatic Conveyors - Definition, Advantages and Disadvantages. Bucket Elevators - Definition, Specification and Uses, Types of Bucket Elevators, Selection of Elevators, Skip Hoists, Freight Elevators, Lifts.

UNIT IV **9 Hours**

CONVEYORS AND ELEVATORS

Types - description - applications of belt conveyors, apron conveyors and escalators pneumatic conveyors, screw conveyors and vibratory conveyors. Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices.

UNIT V **9 Hours**

DESIGN OF MATERIAL HANDLING SYSTEMS

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of arresting gear - Brakes: shoe. design and applications of belt conveyors, apron conveyors. Design of bucket elevators and fork lift trucks.

FOR FURTHER READING

Occupational safety, Energy efficient machines and systems, Storage methods.

Total: 45 Hours

Reference(s)

1. Alexandrov, M., Materials Handling Equipment, MIR Publishers, Moscow, 1982
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, Bangalore, 2002.
4. P.S.G. Tech.,Design Data Book, Kalaikathir Achchagam, Coimbatore, 2012.
5. Rudenko, N., Materials handling equipment, Elnvee Publishers, New Delhi, 1970.
6. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

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.

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. Illustrate the functions of intelligent agents in different environments using search-based problem-solving methods.
2. Compare robotic paradigms by analyzing their structural and behavioral attributes in control applications.
3. Construct path planning strategies using topological references and metric representations in robotic systems.
4. Simulate localization and mapping techniques using sensor models and probabilistic estimation methods.
5. Interpret the role of learning models and natural language processing in AI-based communication systems.

Articulation Matrix

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

UNIT I **8 Hours**

INTRODUTION TO AI AND INTELLIGENT AGENTS

Foundations, History - Intelligent agents, Agents - Nature of Environments, Structure of agents. Problem solving agents - Problem formulation - State space, Search space. Problem reduction - Searching for solutions: Uninformed search strategies. Informed search strategies - Heuristic functions.

UNIT II **11 Hours**

ROBOTIC PARADIGMS

Overview of the Three Paradigms - Hierarchical Paradigm: attributes - representative architectures - Reactive paradigm: attributes - subsumption architecture - potential field methodologies - Designing a reactive implementation: a primitive move-to-goal behavior, an abstract follow-corridor behavior - Designing a Reactive Behavioral System - The Hybrid Deliberative/Reactive Paradigm- Attributes - Architectural Aspects- Managerial Architectures- State-Hierarchy Architectures Model-Oriented Architectures.

UNIT III **9 Hours**

TOPOLOGICAL AND METRIC PATH PLANNING

Landmarks and gateways - relational methods - associative methods - case study - Metric Planning: Configuration Space -Cspace representations - graph based planners - wavefront based planners - Interleaving Path Planning and Reactive Execution

UNIT IV **10 Hours**

LOCALIZATION AND MAP MAKING

Sonar sensor model-Bayesian-Dampster-Shafer theory-HIMM-comparison of methods-localization-exploration.

UNIT V **7 Hours**

LEARNING AND NATURAL LANGUAGE PROCESSING

Forms of learning-NLP: Language models-Natural language for communications-Speech recognition.

Total: 45 Hours

Reference(s)

1. Robin R. Murphy, "Introduction to AI Robotics", MIT Press, 2000.
2. Start Russell, Peter Norvig, "Artificial Intelligence-A Modern Approach", Pearson Education, New Delhi, 2015.
3. Francis X. Govers, "Artificial Intelligence for Robotics", Packt, 2018
4. Roland Siegwart, Illah R. Nourbakhsh , "Introduction to Autonomous Mobile Robots", MIT Press, 2004.
5. Kevin Knight, Elaine Rich, Nair , "Artificial Intelligence", Tata McGraw Hill, New Delhi, 2017.
6. Jon Gabriel, "Artificial Intelligence: Artificial Intelligence for Humans", 1st Edition, Createspace Independent Publishers, 2016.

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.

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. Apply machine learning concepts to analyze and contrast supervised and semi-supervised techniques, inferring their suitability for data-constrained intelligent systems.
2. Interpret the roles of unsupervised and reinforcement learning algorithms and illustrate their application in developing adaptive artificial learning systems.
3. Demonstrate the working principles of artificial neural networks and apply them in real-time control system applications within defined engineering constraints.
4. Design fuzzy logic-based knowledge representation schemes and multi-objective decision-making controllers for intelligent systems in dynamic environments.
5. Formulate and simulate the application of heuristic and non-heuristic algorithms to solve complex optimization problems in intelligent control systems.

Articulation Matrix

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

UNIT I **9 Hours**

SUPERVISED AND SEMI SUPERVISED LEARNING METHODS

Introduction to learning & classifiers - LDA - ANN - Naive Bayes classifier- decision tree Regression- Ordinary Least Squares - linear and Logistic Regression- Gaussian process -Stepwise Regression - Multivariate Adaptive Regression Splines (MARS) - Locally Estimated Scatterplot Smoothing (LOESS) - overview of nearest neighbour - Support vector machines- Temporal difference learning - Q-learning

UNIT II **9 Hours**

UNSUPERVISED

Expectation -maximization (EM) - Vector quantization, Clustering Fuzzy K & C means algorithm - Density-based spatial clustering of applications with noise (DBSCAN) - Conceptual clustering- Association rule learning - Apriori algorithm- SVD

UNIT III **9 Hours**

NEURAL NETWORK

Perceptron - Probabilistic Neural Network (PNN) - Back-Propagation (BPN) - Hopfield Network - Self-Organizing Map (SOM) - Learning Vector Quantization (LVQ) -Adaptive Resonance Theories 1 & 2 - Case studies on GA based algorithm development

UNIT IV **9 Hours**

FUZZY CLASSIFICATION

Basic concepts in Fuzzy Set theory-Fuzzy logic controllers - Principles - Various industrial Applications of Fuzzy logic control - Adaptive Fuzzy systems - Fuzzy Decision making - Fuzzy classification - Fuzzy pattern Recognition - Image Processing applications - Fuzzy optimization - Case studies on fuzzy based algorithm development

UNIT V **9 Hours**

HEURISTIC AND NON HEURISTIC ALGORITHMS

Introduction to genetic algorithm -initialization, selection, mutation and termination Swarm intelligence - PSO-ACO - Tabu search - Reactive search optimization (RSO)- cross-entropy (CE) methods. Case studies on GA based algorithm development.

Total: 45 Hours

Reference(s)

1. Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, Cambridge, London.2014.
2. Klir, G.J. Yuan Bo, Fuzzy sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Pvt. Ltd.New jersey. 2005
3. Randy L. Haupt, Sue Ellen Haupt Practical Genetic Algorithms, Wiley interscience 2004
4. S. Rajasekaran, GA Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, Prentice Hall of India Private Limited, 2003
5. Simon Haykin, Neural Networks - A comprehensive foundation, Prentice Hall, 3rd Edition, 2004
6. https://onlinecourses.nptel.ac.in/noc18_cs26/course

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.

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

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

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

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

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

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional features of key automobile components.
2. Illustrate the working of fuel supply systems and engine auxiliary units in internal combustion engines.
3. Investigate the functions and interactions of components in vehicle transmission and driveline systems.
4. Assess the types of steering, and braking systems used in automobiles to understand vehicle control and safety mechanisms.
5. Analyze the suspension types and emission control technologies in vehicles to ensure compliance with environmental norms and ride quality.

Articulation Matrix

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

UNIT I **9 Hours**

VEHICLE BODY AND AERODYNAMICS

Types of Automobiles - vehicle construction, chassis, frame and body. Vehicle aerodynamics -aerodynamic drag, lift and methods of reducing.

UNIT II **9 Hours**

FUEL SUPPLY MANGEMENT SYSTEMS

Spark ignition engine - Electronic fuel injection system, mono-point and multi Point injection systems. Compression ignition engine- Inline fuel injection system, Common rail direct fuel injection system.

UNIT III **9 Hours**

FUEL SUPPLY MANGEMENT SYSTEMS

Clutch - Types. Gearbox - Types. Automatic transmission system. Fluid flywheel, torque convertors, propeller shaft, slip joint, universal joints, differential and rear axle drives - hotch kiss drive and torque tube drive.

UNIT IV **9 Hours**

STEERING SYSTEM AND BRAKING SYSTEM

Wheels and Tyre Construction. Steering geometry, types of steering and Power steering. Braking Systems -Types-disc brake, drum brake, hydraulic brake and air brake. Electronic Brake Distribution (EBD)

UNIT V **9 Hours**

SUSPENSION SYSTEMS AND EMISSION CONTROL SYSTEMS

Suspension systems - Types - rear suspension and front suspension. Active Suspension System(ASS). Engine emission control - Three-way catalytic converter, Smoke reduction methods. Euro Emission norms and BS Emission norms.

FOR FURTHER READING

Electronic Stability Program(ESP), Traction Control System (TCS), Global Positioning System (GPS), Electric, Hybrid vehicle.

Total: 45 Hours

Reference(s)

1. Crouse and Anglin, Automotive Mechanism, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003.
2. Newton, Steeds and Garet, Motor vehicles, Butterworth Publishers, 2000.
3. S. Srinivasan, Automotive Mechanics, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2003
4. Joseph Heitner, Automotive Mechanics, East-West Press, 2006.
5. H. M. Sethi, Automobile Technology, Tata McGraw Hill Publishing Company Private Limited, New Delhi, 2007.
6. Kirpal Singh, Automobile Engineering Volume.1 and 2, Standard Publishers, New Delhi,2013.

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.

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

Course Outcomes (COs)

1. Apply the principles of automotive electronics to systems such as power supply controllers, suspension controls, safety systems, and infotainment modules in modern vehicles.
2. Assess the operation of electrical subsystems in automobiles including electric drives, starter mechanisms, alternators, and power steering systems for their functional efficiency and reliability.
3. Compare different neural network models such as Perceptron, Adaline, Madaline, and Convolutional Neural Networks in terms of structure, learning methods, and application in automotive systems.
4. Analyze the real-time operating system (RTOS) components and features to understand task scheduling, synchronization, and inter-task communication in embedded automotive environments.
5. Investigate communication protocols such as SPI, I2C, CAN, LIN, and AUTOSAR used in automotive embedded systems to evaluate their role in control and data exchange.

Articulation Matrix

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

UNIT I **9 Hours**

ELECTRONICS IN AUTOMOBILE

Introduction - vehicle power supply controllers and lighting modules, door control modules, Electronic control of suspension, Safety electronics: active safety systems: ABS, ASR, ESP, Infotainment electronics: car audio, telematics systems, navigation systems, multimedia systems.

UNIT II **9 Hours**

ELECTRICALS IN AUTOMOBILE

Electric drives- AC drives, DC drives, Starter drive mechanisms, Starter Switches and Solenoids, Electric power steering, Charging circuits for D.C. Generator, A.C. Alternators.

UNIT III **9 Hours**

AUTOMOTIVE NEURAL NETWORKS

ANN, artificial and biological neuron, learning (supervised and unsupervised learning). McCulloh-Pitts neuron, Linear separability, Hebb network. Perceptron Network, Adaline, Medaline. Convolution Neural Networks- Feed Forward networks, Back propagation network.

UNIT IV **9 Hours**

REAL TIME OPERATING SYSTEM (RTOS)

Introduction - RTOS. Tasks & task states (Pre-emptive & Non-pre-emptive, scheduler, interrupt -Interrupt latency and context switch latency) - Task, multi-tasking, task synchronization, inter-task communication, shared data problem and its prevention - Features of a typical embedded RTOS (MuC/OS-II).

UNIT V **9 Hours**

COMMUNICATION PROTOCOLS

Introduction to control networking-Communication protocols in embedded systems-SPI, I2C, USB. Vehicle communication protocols-Introduction to CAN, LIN, FLEXRAY, MOST, AUTO SAR.

Total: 45 Hours

Reference(s)

1. Robert Bosch,Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, Springer Vieweg ,Plochingen, Germany, 2014.
2. William B Ribbens, Understnading Automotive Electronics- An Engineering Persepective, The Boulevard, Langford Lane, Kidlington, Oxford, 2017.
3. Barry Holembeak, Automotive Electricity and Electronics Delmar Publishers, Clifton Park, USA, 2010.
4. James D Halderman, Automotive Electricity and Electronics, Prentice Hall, USA, 2013.
5. Al Santini, Automotive Electricity and Electronics, Delmar Learning, 2011.
6. Charu C. Aggarwal Neural Networks and Deep Learning: A Text Book

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.

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. Apply the fundamentals of vehicle usage patterns and environmental impacts to identify the need for next-generation transportation technologies.
2. Demonstrate the functional layout, drive train topologies, and regenerative features of electric and hybrid vehicles for various transport applications.
3. Select appropriate electric propulsion systems and motor drives for various electric vehicle applications based on performance requirements.
4. Analyse the energy storage principles to recommend suitable storage technologies for efficient energy management in EVs and HEVs.
5. Interpret the working principles and configurations of different fuel cell technologies for application in sustainable electric mobility.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Usage Pattern of Automobiles in cities and highways, Air Pollution: NOx, CO, HC, PM emission, Global Warming Health Impacts, Petroleum Resources, Induced Costs, Importance of Different Transportation Development, Strategies to Future Oil Supply, Strategies for Next Generation Vehicles.

UNIT II **9 Hours**

ELECTRIC AND HYBRID VEHICLES

Configuration Layouts of early EVs and modern EVs, merits and demerits, Concept of Hybridization, Hybrid electric drive trains - types of hybrid drive train topologies, Speed & Torque Couplings, Types of HEVs, Regenerative braking strategies, Start/Stop in EVs and HEVs, Merits and demerits

UNIT III **9 Hours**

PROPULSION SYSTEM FOR EVS

Basic concept of electric traction, Power-Torque Characteristic curves, Selection of Electric motors, Motors types: DC motor drives, induction motor drives, brushless DC PM motor drives, Switched Reluctance motor drives, starter/alternator, Electric Control Drives.

UNIT IV **9 Hours**

ENERGY MANAGEMENT SYSTEM FOR EVS

Energy storage requirements in HEVs and EVs, Energy storage techniques - battery based energy storage: Engine starter batteries, Traction Batteries, Super capacitor based energy storage and flywheel based energy storage, Hybridization of different energy storage devices

UNIT V **9 Hours**

FUEL CELL TECHNOLOGIES

Fuel cell electric vehicles-operating principle, Fuel cell technologies- alkaline fuel cell- proton exchange Membrane, direct methanol fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, Fuel reformer, Hydrogen storage systems

Total: 45 Hours

Reference(s)

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Boca Raton: CRC Press, 2018
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Boca Raton: CRC Press, 2011
3. AuliceScibioh M. and Viswanathan B., Fuel Cells Principles and Applications, India: University Press, 2009
4. Barbir F., PEM Fuel Cells: Theory and Practice, Burlington: Elsevier, 2012.
5. James Larminie and John Loury, Electric Vehicle Technology-Explained, New York: John Wiley & Sons Ltd., 2012
6. https://nptel.ac.in/courses/108103009/

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.

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

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

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

Course Outcomes (COs)

1. Apply fundamental concepts of vehicle dynamics and vibration theory to analyze dynamic axle loads, road loads, and equations of motion for single, two, and multi-degree-of-freedom systems under various driving conditions.
2. Implement performance mode concepts to evaluate vehicle acceleration, deceleration, and braking behavior using free body diagrams, and assess the impact of systems like ABS and traction control on vehicle performance.
3. Evaluate human response to vibration and assess the performance of passive, semi-active, and active suspension systems using various vehicle models and control strategies.
4. Assess tire dynamics by evaluating tire forces, slip characteristics, road surface interactions, and vibration behavior to assess tire performance under varying operating conditions
5. Analyze vehicle handling characteristics by assessing steering behaviors, control parameters, and the influence of braking and dynamic responses on steady-state and low-speed vehicle control.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Vehicle and Earth fixed coordinate system, Euler angles, Dynamic axle loads - static loads on level ground - low speed acceleration, Loads on Grades. Road loads - rolling resistance - grade resistance. Equation of motion for Forced Undamped and forced Damped Vibration, Single DOF, Two DOF and Multi DOF systems

UNIT II **9 Hours**

PERFORMANCE MODE

Acceleration - free body diagram of accelerating vehicle, maximum transferable tractive force and gradability. Deceleration - free body diagram of decelerating vehicle, maximum decelerating rates, stopping distance and maximum braking force. Prediction of Vehicle performance. Antilock Brake Systems, Traction control

UNIT III **9 Hours**

RIDE MODE

Human response to vibration, Sources of Vibration. Design and analysis of passive, semi-active and active suspension using quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-infinite and skyhook damping. Air suspension system and their properties

UNIT IV **9 Hours**

TIRE DYNAMICS

Tire forces and moments, tire structure, longitudinal and lateral force at various slip angles, rolling resistance, tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tires. Magic formulae tire model, Estimation of tire road friction. Test on various road surfaces. Tire vibration

UNIT V **9 Hours**

HANDLING MODE

Vehicle control - low speed cornering and static steering - Steady-state cornering - steering factors, vehicle control parameters (under steer, neutral steer and over steer), roll steer, compliance steer, ride steer, slip angle steer. Steady state handling - lateral acceleration gain, characteristic speed, yaw velocity gain and critical speed. Effect of braking on vehicle handling

Total: 45 Hours

Reference(s)

1. H.Pacejka, Tire and Vehicle Dynamics, Oxford: Butterworth-Heinemann Elsevier Ltd, 2012
2. R.N. Jazar, Vehicle Dynamics: Theory and Application, NY: Springer, 2017.
3. T.D. Gillespie, Fundamentals of Vehicle Dynamics, Michigan: SAE International, 1992.
4. J.Y. Wong, Theory of Ground Vehicles, John Willey & Sons, 2008.
5. D. Karnopp, Vehicle Dynamics, Stability and Control, Boca Raton: CRC Press, 2013.
6. https://nptel.ac.in/courses/107106080/

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.

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

Course Outcomes (COs)

1. Interpret the role of automotive electronic systems, intelligent vehicle features, and control systems in the context of emerging trends and the need for autonomy in modern vehicles.
2. Analyze the application of computer vision, neural networks, and sensor fusion techniques for accurate environment perception and decision-making in autonomous systems.
3. Investigate the connected vehicle technologies, communication frameworks (V2V, V2I), and cybersecurity aspects to evaluate their impact on safety, user experience, and system integration.
4. Develop IoT-integrated automotive platforms combining diagnostics, driver monitoring, and vehicle analytics to address intelligent mobility and vehicle management needs.
5. Construct autonomous vehicle support systems such as adaptive cruise control, automatic parking, and driver aid technologies by integrating hardware, software, and control logic for enhanced comfort and safety.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Introduction to the Concept of Automotive Electronics, modern trends in Auto industry, various intelligent systems present in the vehicle, Need for IVS, Benefits, Advanced Driver Assistance Electronic Systems Basic Control System Theory applied to Automobiles-Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT II **9 Hours**

COMPUTER VISION AND DEEP LEARNING

Introduction, Computer Vision: - Computer Vision Fundamentals, Deep Learning:- Neural Networks, Deep Neural Networks, Convolutional Neural Networks, Keras ,TensorFlow, Sensor Fusion:- Kalman Filters

UNIT III **9 Hours**

CONNECTED CAR TECHNOLOGY

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Wireless Security Overview Connected Car Display Technology- Center Console Technology, Gauge Cluster Technology, Heads-Up Display Technology, Warning Technology-Driver Notification

UNIT IV **9 Hours**

IOT IN AUTOMOBILES

Developments on IoT in Automotive Sector, Connected Car Services and Applications- Infotainment, Vehicle and Smartphone Integration, Driving Insights- Analytics, On Board Diagnostics, Real Time Driver Monitor, Geo fencing and Speed Monitoring, Stolen Vehicle Tracking, Biometrics Information for Driver Identification, Vehicle Communication- V2V, V2X, V2R, IoT in Intelligent Transportation , Introduction to Autonomous Vehicle.

UNIT V **9 Hours**

AUTONOMOUS VEHICLE COMFORT SYSTEMS AND APPLICATIONS

Introduction- Design overview, circuit diagram and Algorithm, Driver safety systems- ABS, Driver Aid system- ESP, Blind Spot monitoring system, Collision mitigation system, Adaptive Headlamps, Automatic parking system, Eight way seating system, Adaptive cruise control system, Collapsible and tiltable steering column, Lane Departure Warning.

Total: 45 Hours

Reference(s)

1. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner , Autonomous Driving: Technical, Legal and Social Aspects, Springer,2016
2. Hod Lipson, Melba Kurman,Driverless: Intelligent Cars and the Road Ahead,MIT press, 2016
3. Michael E. McGrath , Autonomous Vehicles: Opportunities, Strategies,and disruptions, 2016
4. Vivekwadhwa , Alex salkever, The driver in the driverless car, 2017
5. G. Mullett, Wireless Telecommunications Systems and Networks, Thomson- Delmar Learning, ISNB#1-4018-8659-0, 2006
6. G. Mullett, Basic Telecommunications : The Physical Layer, Thomson-Delmar Learning, ISBN#1-4018-4339-5, 2003

21ME043 / 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.

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. Assess workshop maintenance practices, safety measures, and tools used.
2. Implement the maintenance procedures for engines and their subsystems.
3. Analyze he maintenance procedures for transmission and driveline systems.
4. Demonstrate maintenance process steps for steering, brake, suspension, and wheel systems.
5. Evaluate the maintenance techniques for electrical and air conditioning systems

Articulation Matrix

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

UNIT I **9 Hours**

MAINTENANCE WORKSHOP PRACTICES SAFETY AND TOOLS

Maintenance- Need, Importance, Primary and secondary functions, Policies,- Classifications of maintenance work - Vehicle Insurance - basic Problem Diagnosis. Automotive Service procedures- Work shop operations-Workshop manual- Vehicle identification. Safety- Personnel, Machines, and equipment, vehicles, fire safety- First aid. Basic tools, Special service tools, Measuring instruments, Condition checking of seals, gaskets and sealants. Scheduled maintenance services- service intervals - towing and recovering.

UNIT II **9 Hours**

ENGINE AND ENGINE SUBSYSTEM MAINTENANCE

General Engine service- Dismantling of Engine components- Engine repair - Working on the ancillaries-service of basic engine parts, cooling and lubricating system, Fuel system, Intake and exhaust systems, Electrical system- Electronic fuel injection and engine management service - Fault diagnosis -servicing emission controls.

UNIT III **9 Hours**

TRANSMISSION AND DRIVELINE MAINTENANCE

Clutch- general checks, adjustment and service -Dismantling, Identifying, Checking and assembling of transmission, transaxle- road testing -removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joint - Rear axle service points -Removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

UNIT IV **9 Hours**

STEERING, BRAKE, SUSPENSION ANDWHEEL MAINTENANCE

Inspection, Maintenance and service of steering linkage, steering linkage, steering column, rack and pinion steering, recirculating ball steering service- worm type steering, power steering system. Inspection, maintenance and service of hydraulic brake, drum brake, disc brake, parking brake, bleeding of brakes. Inspection, Maintenance and service of McPherson strut, coil spring, leaf spring, shock absorber, Dismantling and assembling procedures. Wheel alignment and balance, Removing and fitting of tyres, tyre wear and tyre rotation.

UNIT V **9 Hours**

ELECTRICAL, AIR CONDITIONING AND BODY MAINTENANCE

Maintenance of batteries, starting system, charging system and body electrical- Fault Diagnosis using scan tools. Maintenance of Air conditioning parts- compressor, condenser, expansion valve, evaporator-replacement of hoses- leak detection - AC Charging - Fault Diagnosis. Vehicle Body repair- panel beating, tinkering, soldering, polishing, painting.

Total: 45 Hours

Reference(s)

1. Ed May, Automobile Mechanics Volume one, McGraw Hill Publications, 2003.
2. Ed May, "Automotive Mechanics Volume Two" , Mc Graw Hill Publications, 2003
3. Crouse W H, Automotive Transmissions and Power Trains, McGraw Hill Book Co., 5th edition, 1976.
4. Bosch Automotive Handbook, Tenth Edition, 2018

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,

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the proper system of symbols and notations used in engineering drawings to communicate design intent regarding the shape, size, orientation, and location of parts and assemblies.
2. Design individual and related geometric features using form, profile, orientation, location, and runout tolerances.
3. Analyze the specification of profile and radius refinements using the profile of a conical feature.

Articulation Matrix

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

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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Interpret the principles of Lean Manufacturing including Toyota Production System, workplace organization, and types of wastes to assess value flow and support continuous improvement.
2. Apply lean tools such as Just-In-Time, Kanban, TPM, 5S, and SMED to eliminate unnecessary process steps, reduce setup time, and implement lean strategies in production environments.

Articulation Matrix

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

UNIT 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

Programme Outcomes (POs)

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

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.

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

Course Outcomes (COs)

1. Illustrate the quality control problem-solving process using structured methodologies and steps.
2. Demonstrate the use of quality control tools to analyze and solve basic quality-related problems.

Articulation Matrix

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

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

Programme Outcomes (POs)

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

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.

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

Course Outcomes (COs)

1. Apply structured problem-solving techniques using the seven-step story approach and quality control tools to identify and resolve quality-related issues in engineering processes.
2. Analyze quality problems using tools like cause-and-effect diagrams, Pareto charts, and control charts, and validate solutions through systematic observation, root cause analysis, and standardization techniques.

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	-	-	-	-	-	-	-	-	-	-	3	3	-

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

Programme Outcomes (POs)

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

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. Analyze the influence of exhaust manifold geometry, flow uniformity, and pressure losses on system performance using theoretical concepts.
2. Design the automotive exhaust manifold using CATIA V5 considering structural layout, component integration, and emission control requirements.
3. Analyze exhaust gas flow in the manifold using CFD to optimize CPSI, space velocity, and pressure drop for improved pollution control.

Articulation Matrix

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

UNIT I **15 Hours**

AUTOMOTIVE EXHAUST SYSTEM

Exhaust system - Exhaust system Function -Parts - Types - Catalytic Convertor - 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.

Programme Outcomes (POs)

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

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.

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

Course Outcomes (COs)

1. Apply the principles of Lean Manufacturing, including the Toyota Production System, workplace organization, waste identification, and visual control methods, to enhance operational efficiency in manufacturing and service sectors.
2. Analyze the continuous improvement methodologies such as KAIZEN by identifying gaps, formulating problem statements, collecting and analyzing data, and executing corrective and preventive actions to achieve strategic business goals.

Articulation Matrix

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

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 - Underutilization 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.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Interpret the key provisions and procedures of the Indian Patent Act relevant to filing, examination, and grant of patents.
2. Assess the patentability of inventions based on the criteria outlined in Indian patent law.
3. Analyze the legal framework governing patent rights, infringement, and enforcement mechanisms in India.

Articulation Matrix

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

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.

Programme Outcomes (POs)

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

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.

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 Indian railway system and illustrate the classification and functions of different types of rails.
2. Apply the principles of railway engineering to describe the components and structure of the railway track system.

Articulation Matrix

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

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.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Analyze the classification of engineering glasses and relate their properties to appropriate industrial applications
2. Illustrate the complete glass manufacturing process and describe various treatment techniques used in the glass industry.

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

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 TOOL DESIGN AND MANUFACTURING 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.

Programme Outcomes (POs)

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

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.

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. Apply the design considerations, molding techniques, and defect-avoidance methods in plastic component manufacturing for applications in industries such as automotive and consumer goods.
2. Analyze various molding defects such as warpage, weld lines, and sink marks to infer their root causes and recommend suitable corrective methods in plastic processing.
3. Design plastic product tooling systems by integrating elements such as core-cavity structure, heating/cooling circuits, and material specifications for effective molding and post-processing operations.

Articulation Matrix

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

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 -Warpage, 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.

Programme Outcomes (POs)

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

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. Implement the 5S methodology by applying systematic workplace organization techniques including SEIRI, SEITON, SEISO, SEIKETSU, and SHITSUKE to improve efficiency, safety, and quality in engineering environments.
2. Analyze the impact of 5S implementation through practical audits, visual controls, and continuous improvement strategies to sustain a clean and productive work environment.

Articulation Matrix

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

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

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PSO3.Address all the fluid flow and energy transfer related problems of mechanical systems.

Course Outcomes (COs)

1. Apply the principles of the Energy Conservation Act 2001 to evaluate energy audit processes and recommend strategies for efficient energy usage.
2. Apply the specifications and operational techniques of energy auditing instruments to measure parameters like pressure, flow, power consumption, and waste heat recovery.
3. Analyze the performance and limitations of energy auditing instruments, including their suitability for specific applications, to optimize energy measurement and calculation techniques.

Articulation Matrix

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

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.

Programme Outcomes (POs)

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

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. Analyze the fundamentals of control valves and illustrate their manufacturers, global presence, and market outlook.
2. Apply the principles of control valve operation to interpret their industrial applications in power plants and compressors.

Articulation Matrix

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

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.

Programme Outcomes (POs)

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

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 gear design principles to select the appropriate type of gears, material, and heat treatment method for industrial gearbox design.
2. Design a gearbox for effective operation by selecting the proper bearing, seal, and lubrication system.
3. Analyze planetary gearbox configurations to calculate load distribution and bearing life and recommend maintenance strategies.

Articulation Matrix

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

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

Programme Outcomes (POs)

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

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.

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.

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

Course Outcomes (COs)

1. Apply the stages of the product development process and the principles of product validation to ensure quality, reliability, and performance in engineering products.
2. Apply international testing standards (ISO, ASTM, JIS, MIL, DIN) to perform and interpret mechanical, chemical, electrical, and environmental tests for product evaluation.
3. Simulate testing environments and procedures using appropriate equipment, ensuring proper maintenance, calibration, and documentation in compliance with NABL accreditation norms.

Articulation Matrix

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

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 ingression protection, Dust ingression 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.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the 8D Problem Solving Methodology and Why-Why Analysis to systematically identify, analyze, and resolve engineering problems.
2. Apply the 7 QC Tools, including Pareto Diagram, Cause and Effect Diagram, Control Charts, and Histograms, to interpret data and improve quality in practical industrial scenarios.

Articulation Matrix

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

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.

Programme Outcomes (POs)

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

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.

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

Course Outcomes (COs)

1. Apply the principles of Advanced Product Quality Planning (APQP) including process flow, Quality Function Deployment (QFD), Failure Mode and Effects Analysis (FMEA), and control plans to ensure product quality in manufacturing and service sectors.
2. Analyze the Production Part Approval Process (PPAP) by interpreting process flow diagrams, capability studies, design records, and corrective & preventive actions to meet customer-specific requirements and regulatory standards.

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	-	-	-	-	-	-	-	-	-	-	-	3	3

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.

Programme Outcomes (POs)

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

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. Analyze the types of shafts and their industrial applications, and illustrate the functions of components fitted onto shafts.
2. Apply design principles to calculate stress levels in shafts and develop optimum shaft designs considering stress concentration and factor of safety.
3. Demonstrate the theory and calculations of shaft component assembly to analyze assembly and disassembly procedures.

Articulation Matrix

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

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.

Programme Outcomes (POs)

PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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.
PSO1.Design, analyse and evaluate the performance of mechanical systems.

Course Outcomes (COs)

1. Apply industrial safety procedures by conducting safety audits, measuring workplace environmental conditions, and complying with ISO 14001 and ISO 45001 standards.
2. Design an emergency preparedness plan by analyzing fire accident scenarios, identifying prevention and control measures, and conducting mock drills using appropriate fire detection and suppression systems.

Articulation Matrix

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

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 IS0 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.

Programme Outcomes (POs)

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

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

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

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

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

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

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 principles of buoyancy, stability, and waterproofing to illustrate the functional requirements of underwater robot components and propulsion systems.
2. Analyze the influence of hydrodynamic forces, flow patterns, and pressure distribution on the locomotion and performance of underwater robots.
3. Design and simulate the structural model of an underwater robot, including the pressure hull, skeletal frame, and fluid flow characteristics using Navier-Stokes-based analysis.

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	3	2	-	-	2	-	-	-	1	1	-	2	3	-	-
3	2	2	3	-	2	-	-	-	1	1	-	2	3	-	-

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.

Programme Outcomes (POs)

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

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. Design an automated industrial process by incorporating appropriate sensors, actuators, and control logic to streamline production operations effectively.
2. Develop a simulation model in CODESYS integrated with Factory I/O to analyze, test, and validate the control logic for real-time industrial automation systems.

Articulation Matrix

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

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, Electro pneumatics, Hydraulics, and Electro hydraulics. 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.

Programme Outcomes (POs)

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

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. Design the forward and inverse kinematic models for a mobile robot using the Robot Operating System (ROS) platform to simulate realistic robotic movements.
2. Develop a simulation model in CODESYS integrated with Factory I/O to analyze, test, and validate the control logic for real-time industrial automation systems.

Articulation Matrix

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

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.

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. Interpret the characteristics and data types of C++ language through practical examples.
2. Develop C++ programs using classes and objects to solve real-world problems.
3. Construct C++ programs implementing operator overloading and inheritance to solve real-world problems.
4. Apply polymorphism and file stream concepts to implement effective C++ solutions for data-driven tasks.
5. Design C++ applications using templates and integrate exception handling to enhance software robustness.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading. (sona)

UNIT II **9 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**

OPERATOR OVERLOADING AND INHERITANCE

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **9 Hours**

POLYMORPHISM AND FILE STREAMS

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer- Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **9 Hours**

TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005.
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

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.

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 use of classes, objects, and control structures in Java to develop basic applications.
2. Construct Java applications using inheritance, packages, and exception handling to solve real-world problems.
3. Interpret Java I/O concepts to handle various input and output operations in structured Java programs.
4. Develop Java programs for performing string manipulation operations.
5. Design graphical user interfaces (GUI) using Java AWT to implement event handling and connect to databases.

Articulation Matrix

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

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. Interpret the components of Data Warehousing architecture and the business analysis process with practical examples.
2. Assess the process of Data Mining and demonstrate preprocessing techniques for effective data cleansing in real-world datasets.
3. Apply association rule mining techniques to discover frequent patterns and correlations from structured data.
4. Analyze classification and clustering algorithms to solve high-dimensional data problems using performance metrics and validation techniques.
5. Illustrate data mining techniques for extracting insights from complex data objects such as images, text, and graphs.

Articulation Matrix

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

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. Interpret the foundational concepts and principles of e-learning through case-based examples.
2. Illustrate technology-mediated communication strategies used in e-learning environments by evaluating tools and platforms.
3. Demonstrate the process of content creation and learning management in different e-learning systems.
4. Analyze teaching and learning strategies used in e-learning environments to identify their effectiveness.
5. Assess real-time applications of e-learning to determine their impact on learner engagement and outcomes.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**
TECHNOLOGIES
Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**
MANAGEMENT
Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**
TEACHING-LEARNING PROCESS
Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**
APPLICATIONS
Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

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.

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, techniques, and real-time applications of text mining using domain-specific datasets.
2. Interpret the process of content and sentiment analysis in analyzing user-generated data for opinion mining.
3. Illustrate web analytics using suitable models and frameworks for user behavior analysis and reporting.
4. Implement social network analytics techniques by applying centrality measures and graph-based models to real-world networks.
5. Analyze social media data to derive actionable insights through trend analysis and influence detection techniques.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
2	3	1	-	-	2	-	-	-	-	-	-	-	-	-	-
3	3	1	-	1	3	-	-	-	-	-	-	-	-	-	-
4	3	1	-	1	3	-	-	-	-	-	-	-	-	-	-
5	2	3	-	3	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 Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

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 semiconductor devices (diodes, transistors, FETs, MOSFETs) in rectifiers, regulators, and amplifiers and analyze their electrical characteristics for effective circuit operation.
2. Analyze the performance of operational amplifiers under various configurations (inverting, non-inverting, differential, integrator, differentiator) and justify their applications in analog signal processing.
3. Formulate optimized logic expressions with Karnaugh maps and integrate them into combinational circuit designs
4. Investigate the operation of sequential circuits including flip-flops, counters, and registers, and evaluate memory structures for digital system applications.
5. Evaluate the performance of A/D and D/A converters and classify them with respect to parameters such as resolution, accuracy, linearity, and conversion speed.

Articulation Matrix

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

UNIT I **9 Hours**

SEMICONDUCTORS DEVICES

Conductor, Semiconductors & Insulators, Semiconductors: intrinsic & extrinsic, energy band diagram - Mobility - Electrons and holes - The P-N junction diode - Zener diode - Avalanche effect- Rectifier Circuits Half wave, Full wave circuits, Efficiency, PIV, Ripple factor and AC and DC current and voltage in rectifier. PNP and NPN Bipolar junction Transistors - H parameters equivalent circuit - Common emitter amplifier - DC behavior: the load slope and the Q point - AC behavior - Emitter follower amplifier - Field effect transistors: JFET and MOSFET.

UNIT II **9 Hours**

OPERATIONAL AMPLIFIERS: DC PERFORMANCE

The operational amplifier - Input resistance, Output resistance, Open loop gain - Bias currents - Offset currents - Offset voltage - Differential mode gain - Common mode gain - Common mode rejection ratio - Negative feedback - Open loop gain and closed loop gain - Inverter amplifier - Non-inverter amplifier - The voltage follower - Transimpedance amplifier (Current to voltage converter) - Differential amplifier. Adders, Subtractors, Comparator, Integrator and Differentiator.

UNIT III **9 Hours**

DIGITAL TECHNIQUES: COMBINATIONAL CIRCUITS

Numbering systems - Binary, octal and hexadecimal numbers - Boole algebra - Conversion and operations - AND gate- OR gate - Inverter - NAND gate - NOR gate - Exclusive OR gate. Morgans laws. Combinational Circuits: Truth tables, logic expressions, Logic simplification using K- map, half and full adder/subtractor, multiplexers, demultiplexers, Logic families :TTL and CMOS.

UNIT IV **9 Hours**

DIGITAL TECHNIQUES: SEQUENTIAL CIRCUITS

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flop (FF) types: RS type. JK FF. JK FF Master slave. D FF. T FF. Flip Flop Conversion. Shift registers, Counters. Memories Structure: address and data bus. ROM, PROM, EPROM and flash RAM. Volatiles Memories: RAM, SRAM, DRAM. Addressing modes.

UNIT V **9 Hours**

DIGITAL TO ANALOG CONVERTERS AND ANALOG TO DIGITAL CONVERTERS

Digital to Analog Converters : Input latch. Binary Weighted Resistor Network. R-2R Ladder Resistor Network. Pulse Width Modulation . Resolution. Accuracy. Linearity. Zero Offset. Settling Time. Glitches. Analog to Digital Converters: Sampling. Real time sampling and equivalent time sampling. Sampling frequency. Sampling theorem (Nyquist). Anti-aliasing filtering. Sampling and holding. Conversion.

Total: 45 Hours

Reference(s)

1. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education,2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw-Hill,2010.
3. Ramakant A.Gayakwad, OP-AMP and Linear IC"s , Prentice Hall of India, 2002.
4. D.RoyChoudhry, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd., 2000.
5. Thomas L.Floyd, Digital Fundamentals, Prentice Hall, 11th Edition, 2015.
6. M.Morris Mano, Michael D Ciletti Digital Design 4th edition Pearson, 2011.

21OEC02 MICROCONTROLLER PROGRAMMING 3 0 0 3

Course Objectives

- To understand the series of microcontrollers in terms of architecture, Programming and Interfacing.
- To impart knowledge on the development of assembly language programs.
- To study the programming of PIC series of microcontrollers and learn building of hardware circuits using PIC 16F series of Microcontrollers.
- To impart knowledge on the interfacing techniques of various PIC hardware.
- To learn the emerging trends in the design of advanced Microcontrollers.

Programme Outcomes (POs)

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

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

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

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

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

Course Outcomes (COs)

1. Apply the components, architecture, and functionalities of 8051 microcontrollers in simple embedded applications
2. Develop assembly language programs on 8051 to implement timers, counters, and peripheral-based applications
3. Analyze the features, instruction set, and operational modes of PIC microcontrollers across different versions
4. Integrate peripherals such as ADC, DAC, sensors, and communication modules with PIC microcontrollers for application-oriented designs
5. Investigate the architecture, instruction sets, and programming models of ARM microcontrollers to address advanced embedded system applications

Articulation Matrix

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

UNIT I **9 Hours**

8-BIT MICROCONTROLLER

Introduction-Intel 8051 architecture-Counters and Timers-Serial Interface- Interrupts- Interfacing to external memory and 8255- Instruction set- Address modes.

UNIT II **9 Hours**

8051 ALP AND APPLICATIONS

Assembly language program- Timers and Counters programming- DAC- ADC- Sensor- Keyboard and LCD.

UNIT III **9 Hours**

PIC MICROCONTROLLER

PIC Microcontroller features- PIC Architecture, Program Memory, Addressing Modes, Instruction Set, Instruction Format- Byte-oriented Instructions- Bit-oriented Instructions- Literal Instructions- Control Instructions (CALL & GOTO)- Destination Designator. MPLAB overview: Using MPLAB, Toolbars, Select Development Mode and Device type, Project, Text Editor, Assembler, MPLAB operations.

UNIT IV **9 Hours**

PIC HARDWARE

Reset, Clock, Control registers, Register banks, Program Memory Paging, Ports, Interrupts, Timer and Counter, Watchdog Timer, Power up timer, Sleep mode, I2C bus- A/D converter.

UNIT V **9 Hours**

HIGH PERFORMANCE RISC ARCHITECTURE

ARM: The ARM architecture- ARM organization and implementation- The ARM instruction set- The THUMB instruction set- Basic ARM Assembly Language Program- ARM CPU Cores.

FOR FURTHER READING

Introduction- Architecture- Registers- Memory- Instruction set- Addressing Modes- I/O Pins- Timers- Counters- Interrupts.

Total: 45 Hours

Reference(s)

1. Ayala, Kenneth, "The 8051 Microcontroller", Thomson, 3rd Edition, 2004.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Person Education, 2nd Edition, 2004.
3. John B.Peatman, "Design with Microcontrollers", Person Education", 1st Edition, 2004.
4. Steave Furber, "ARM system-on-chip architecture" Addison Wesley, 2nd Edition, 2000.
5. A.V.Deshmukh, "Microcontrollers: Theory and Applications", Tata Mc Graw Hill, 12th reprint, 2005.

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	PSO1	PSO2	PSO3
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 andPM waveforms, phase deviation and modulation index, frequency deviation and percent modulation,Frequency analysis of angle modulated waves. Bandwidth requirements for Angle modulated waves

UNIT II **9 Hours**

DIGITAL COMMUNICATION

Introduction, Shannon limit for information capacity, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Minimum Shift Keying (MSK),Phase Shift Keying (PSK), BPSK, QPSK, 8 PSK Quadrature Amplitude Modulation (QAM), Bandwidth Efficiency,Comparison of various Digital Communication System (ASK - FSK - PSK - QAM).

UNIT III **9 Hours**

DIGITAL TRANSMISSION

Introduction, Pulse modulation, PCM , PCM sampling, sampling rate, signal to quantization noise rate,companding, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission, Intersymbol interference, eye patterns.

UNIT IV **9 Hours**

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques, wireless communication, TDMA and CDMA in wireless communication systems, source coding of speech for wireless communications.

UNIT V **9 Hours**

SATELLITE AND OPTICALCOMMUNICATION

Satellite Communication Systems-Keplers Law,LEO and GEO Orbits, footprint, Link model-OpticalCommunication Systems-Elements of Optical Fiber Transmission link, Types, Losses, Sources and Detectors.

Total: 45 Hours

Reference(s)

1. Wayne Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson Education, 2007.
2. Simon Haykin, Communication Systems, 4th Edition, John Wiley & Sons., 2001.
3. H.Taub,D L Schilling,G Saha ,Principles of Communication,3/e,2007.
4. B.P.Lathi,Modern Analog And Digital Communication systems, 3/e, Oxford University Press, 2007
5. Dennis Roddy, "Satellite Communications", Third Edition, Mc Graw Hill International Editions, 2001.
6. Gerd Keiser, Optical Fiber Communication, McGraw-Hill International, Singapore, 4th edition., 2011.

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	PSO1	PSO2	PSO3
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 Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch,Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

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	PSO3
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

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

UNIT III **9 Hours**

DATA ACQUISITION

Introduction to data acquisition on PC, Sampling fundamentals, Input/output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

UNIT IV **9 Hours**

VI TOOLSETS

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory.

UNIT V **9 Hours**

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Total: 45 Hours

Reference(s)

1. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, Prentice Hall, New Jersey,1997.
2. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw Hill, Newyork, 1997.
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newness, 2000.

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	PO10	PO11	PO12	PSO1	PSO2	PSO3
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 cards, brain surgery, plastic surgery, gynaecology and oncology.

Total: 45 Hours

Reference(s)

1. John M. Senior, Optical Fiber Communications - Principles and Practice, Prentice Hall of India, 2010.
2. John F. Ready, Industrial Applications of Lasers, Academic Press, 2012.
3. Gerd Keiser, Optical Fiber Communication, Mc Graw Hill, New York, 2013.
4. S.C. Gupta, Textbook on Fiber Optics Communications and its application, Prentice Hall of India, 2012.
5. John Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2011.
6. R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2011.

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.

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.

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

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

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

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of biorefineries, co-products of biorefineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

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.

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

Course Outcomes (COs)

1. Assess the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Select the Traditional fermented foods products based on its raw material
4. Find a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

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

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

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.

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

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Assess the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Apply the voluntary regulatory standards as per application
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

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

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

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.

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

Course Outcomes (COs)

1. Implement various post-harvest handling practices to effectively store fruits and vegetables, ensuring quality preservation.
2. Analyze suitable preservation methods (such as sugar, salt, or dehydration) to produce value-added products from fruits and vegetables.
3. Evaluate the need for low temperature and irradiation methods to preserve specific fruits and vegetables, assessing their effectiveness.
4. Apply concentration and fermentation techniques to preserve fruits and vegetables, enhancing their shelf life and quality.
5. Implement the canning process for preserving fruits and vegetables, ensuring product safety and quality.

Articulation Matrix

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

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

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 processing technologies used for cereals.
2. Analyze the composition and nutritional value of millets.
3. Understand the changes in pulses and legumes during processing.
4. Develop skills in oilseed processing technology.
5. Understand the relationship between storage, processing, and quality of food grains.

Articulation Matrix

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

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats- Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

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	PSO3
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.
PSO2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost.

Course Outcomes (COs)

1. Assess the elements of interior design concepts and resolve the personality requirements
2. Carry out graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Analyze the roles and responsibilities of an interior designer.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

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	PSO3
1	2	3	2	-	-	-	-	1	-	-	-	-	2	2	-
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	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.

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

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

Course Outcomes (COs)

1. Analyze the origin of nanomaterials from ancient applications to modern nanotechnology
2. Compare the different types of methods adopted for synthesizing nanomaterials
3. Analyze the characterization techniques for analyzing nanomaterials
4. Analyze the magnetic properties of nanomaterials and their applications in data storage and spintronics
5. Organize the nanomaterials developed for advanced technological applications

Articulation Matrix

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

NANO SCALE MATERIALS

Introduction-Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties -differences between bulk and nanomaterials and their physical properties.

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", Imperials College Press, 2011.
4. T. Pradeep, "NANO: The Essentials Understanding Nanoscience and Nanotechnology", McGraw - Hill Education (India) Ltd, 2012
5. Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan, "Nanoscale Science and Technology", John Wiley and Sons Ltd, 2006
6. Viswanathan B, AuliceScibioh M, "Fuel cells: Principles and Applications", University Press, 2009.

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.

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

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. Analyze the formation of drift current due to the movement of charge carriers under an electric field
2. Analyze the energy band diagram in thermal equilibrium and space charge width of PN junction
3. Analyze the operation of a Bipolar Junction Transistor (BJT) in active, cutoff, and saturation modes
4. Apply the principles of charge storage in floating-gate transistors for non-volatile memory applications
5. Outline the efficiency factors affecting the performance of opto-electronic devices

Articulation Matrix

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

UNIT I **9 Hours**

ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density

9 Hours

UNIT II

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.

9 Hours

UNIT III

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

9 Hours

UNIT IV

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

9 Hours

UNIT V

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.

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

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

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

PSO2. 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 transition mechanisms and the components of a laser system
2. Compare the different types of lasers based on pumping method, active medium and energy levels
3. Compute the rotation of earth, velocity and distance using lasers and apply the same for day today applications
4. Analyze the role of lasers in surgical and endoscopy applications
5. Apply the laser techniques in industrial applications

Articulation Matrix

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

UNIT I **9 Hours**

LASER FUNDAMENTALS

Introduction - principle - absorption and emission of light - thermal equilibrium - Einstein's prediction - Einstein's relations - A and B coefficients - condition for large stimulated emission - spontaneous and stimulated emission in optical region - light amplification - condition for light amplification - population inversion- Components of lasers - pumping methods - pumping mechanisms - optical resonator

UNIT II **9 Hours**

LASER BEAM CHARACTERISTICS AND TYPES

Characteristics of laser - Classification of lasers - principle, construction, working, energy level diagram and applications of molecular gas laser (CO2 laser) - liquid laser (dye laser) - excimer laser - Solid state laser (Nd:YAG laser) - semiconductor laser (homojunction laser).

UNIT III **9 Hours**

LASERS IN SCIENCE

Introduction - Harmonic generation (SHG) - Stimulated Raman emission - lasers in chemistry - laser in nuclear energy - lasers and gravitational waves - rotation of the earth - measurement of distance - Light detection And Ranging (LIDER) - velocity measurement - holography

UNIT IV **9 Hours**

LASERS IN MEDICINE AND SURGERY

Light induced biological hazards: Eye and skin - Eye laser surgery - photocoagulations - homeostasis - dentistry - laser angioplasty - different laser therapies - advantages & disadvantages - laser endoscopy.

UNIT V **9 Hours**

LASERS IN INDUSTRY

Applications in material processing: laser welding - hole drilling - laser cutting - Lasers in electronics industry: information storage - bar code scanner- Lasers in defence: laser based military weapons - laser walls.

Total: 45 Hours

Reference(s)

1. K. Thiyagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015
2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013
3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006
4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009
5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006
6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006

21OPH04 BIOPHOTONICS 3 0 0 3

Course Objective:

- To understand the light-matter interaction in biological cells or tissues by using the principles of optics and lasers.
- To apply the properties of biological cells or tissues in biomedical applications by various optical imaging, sensing and activation techniques.
- To analyze the concepts of Modern optical measurement techniques and devices in early detection of disease and cure them.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Infer the laws of optics and lasers to interpret the biological cells and tissues. Analyze the fundamental laws of optics and their role in light interaction with biological cells and tissues
2. Apply the principles of light interaction with biological tissues to enhance imaging resolution and contrast
3. Use laser tweezers techniques to infer the activities of cells (tissues) and explain the single molecule detection processes in medical diagnosis.
4. Outline the properties of ultra short laser pulses and tissue engineering to rectify the affecting factors in biological cells.
5. Compare the various types of bio-imaging methods to detect the infected cells and molecules in biological science.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO BIOPHOTONICS

Light as Photon Particles – Coherence of light - lasers – classification of lasers – Mechanisms of Non-linear Optics (NLO) processes associated with Biophotonics - Light scattering mechanisms: Rayleigh scattering, Miescattering, Brillouin Scattering, Raman Scattering -Different light sources – Quantitative description of light: Radiometry

UNIT II **9 Hours**

PHOTOBIOLOGY

Interaction of light with cells and tissues – Light – Tissue Interaction Variables – Light –Tissue Interaction Theory: Radiative Transport Theory – Photo process in biopolymers – In Vivo Photoexcitation – photo-induced physical, chemical, thermal and mechanical effects in biological systems – Optical biopsy – Single molecule detection

UNIT III **9 Hours**

BIONANO PHOTONICS

Laser Microtools, Semiconductor quantum dots for bioimaging, Metallic nanoparticles and nanorods for biosensing – Optical biosensors: Fibre-Optic, evanescent wave, surface Plasmon resonance (SPR) based biosensors – biomaterials for photonics – Principle and design of laser tweezers – laser trapping and dissection for biological manipulation.

UNIT IV **9 Hours**

TISSUE ENGINEERING WITH LIGHT

Basics of tissue optics: Light absorption and scattering in tissues, Wavelength effects and spectra– the therapeutic window, Light penetration in tissues – Absorbing agents in tissues and blood –Skinoptics, response to the UV radiation, Optical parameters of tissues – tissue welding – tissue contouring – tissue regeneration – Femto laser surgery – low level light therapy and photo dynamic therapy

UNIT V **9 Hours**

BIO-IMAGING TECHNIQUES AND ITS APPLICATIONS

An overview of optical imaging – Fluorescence Microscopy – Scanning Microscopy – In vivo Confocal Microscopy – Multi photon Microscopy – Optical Coherence Tomography (OCT) – Fluorescence Resonance Energy Transfer (FRET) imaging – fluorescence lifetime imaging Microscopy (FLIM) – Nonlinear optical imaging – Coherent Anti-stokes Raman Scattering – Bioimaging Applications.

Total: 45 Hours

Reference(s)

1. Introduction to Biophotonics, ParasN.Prasad, WileyInter-science, AJohnWiley & Sons, Inc., Publication (Class notes are developed mainly based on this book.)
2. Introduction to Biomedical Imaging, Andrew G.Webb, 2002, IEEE Press.
3. Biomedical Optics: Principles and Imaging, Lihong.V.Wang, Hsin.-I.Wu, 2007, Wiley Interscience 2007. & "An Introduction to Biomedical Optics", R.Splinterand B.A.Hooper, Taylor & Francis
4. Bioimaging Current Concepts in Light and Electron Microscopy, DouglasE.Chandler & Robert W.Roberson, Jones and Bartlett publishers.
5. Optical Imaging and Microscopy : Techniques and Advanced Systems, Peter Török and Fu-JenKao, 2004, Springer.

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 proprties of structures and components of life

Programme Outcomes (POs)

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

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

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. Analyze the structural and mechanical differences between soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Analyze the optical and electro-optical properties of liquid crystals used in display technologies
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

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

UNIT I 9 Hours

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggragation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

REFERENCES

1. Richard A L Jones, Soft Condensd Matter, Oxford University Press, UK, 2002
2. Masao Doi, Soft Matter Physics,Oxford University Press, UK, 2013.
3. Ian W. Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

21OCH01 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.

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. Apply fundamental principles of corrosion science to calculate corrosion rates, analyze metal degradation and interpret Pourbaix diagrams to predict corrosion behavior in various industrial environments.
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Analyze the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Analyze the rate of corrosion on metals using electrochemical methods of testing
5. Analyze the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

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

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.html

21OCH02 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.

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

Course Outcomes (COs)

1. Apply knowledge of polymerization mechanisms to predict the formation of different polymer products under various reaction conditions and catalysts
2. Apply suitable polymerization techniques to synthesize the high quality polymers
3. Apply the structural, thermal, and mechanical properties of polymers for different industrial applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

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

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2008
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

21OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply principles of electrochemistry to evaluate performance parameters such as energy density, charge efficiency, and cycle life for different cell types.
2. Asses the suitability of various primary, secondary, and reserve batteries for portable electronics and EV applications considering specifications, safety, and recycling aspects.
3. Evaluate and compare different fuel cell types in terms of working principles, components, applications, and environmental impact to propose suitable technology for a given scenario.
4. Develop efficient hydrogen energy solutions by integrating suitable production, storage, and application methods while addressing limitations.
5. Analyse future prospects of renewable fuels and design strategies to enhance efficiency and economy of hydrogen and solar-based energy conversion systems.

Articulation Matrix

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

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium,and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

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.

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

Course Outcomes (COs)

1. Apply the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

21OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Programme Outcomes (POs)

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply management principles to assess managerial roles, business types, and current organizational trends.
2. Implement planning processes and tools to create objectives, policies, and decisions
3. Assess organizational structures and HR practices for effective system design.
4. Analyze motivation, leadership, and communication strategies to influence organizational behavior.
5. Develop control techniques and IT tools to monitor performance and productivity.

Articulation Matrix

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

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

21OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- To develop an understanding of the basics of entrepreneurship and its role in economic development.
- To explore fundamental concepts of creativity and innovation for effective idea generation techniques.
- To familiarize students with the principles of business laws relevant to entrepreneurial ventures.
- To empower learners to apply financial tools for project evaluation and resource management.
- To enhance the ability to manage operations through strategic planning and quality improvement techniques.

Programme Outcomes (POs)

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

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

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

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

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. Apply the principles of entrepreneurship to identify types, characteristics, and processes of entrepreneurial ventures in economic development.
2. Analyze various creative idea-generation techniques such as brainstorming, lateral thinking, and analogies to develop innovative business solutions.
3. Interpret business laws including contract acts, negotiable instruments, and company law components to ensure legal compliance in entrepreneurial contexts.
4. Demonstrate the use of financial tools such as break-even analysis, cash flow analysis, and project evaluation to assess business viability within the course duration.
5. Design an integrated operations strategy by planning layout, capacity, inventory systems, and quality improvement methods such as lean and six sigma for an entrepreneurial setup.

Articulation Matrix

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

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

21OGE03 ENTREPRENEURSHIP DEVELOPMENT II 3 0 0 3

Course Objectives

- To develop an understanding of marketing strategies, market segmentation, and the marketing mix to effectively address business challenges.
- To equip learners with the knowledge of human resource planning, recruitment, and training, alongside insights into labor laws like the Factories Act 1948.
- To familiarize students with the principles of direct and indirect taxation, including GST, income tax, and corporate tax, to ensure compliance and financial efficiency.
- To explore fundamental concepts of government policies, institutional support, and financial assistance available for entrepreneurial ventures.
- To train students to effectively prepare comprehensive business plans encompassing technical, financial, and market feasibility to evaluate entrepreneurial viability.

Programme Outcomes (POs)

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

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

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

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

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

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 marketing segmentation, targeting, and positioning techniques to formulate appropriate marketing strategies for a proposed business case.
2. Analyze human resource functions such as recruitment, selection, and development to illustrate effective HR planning and HRIS implementation in small and medium enterprises.
3. Investigate the impact of direct and indirect taxation systems, including GST and MAT, to assess their implications on business profitability and legal compliance.
4. Interpret the roles of government and institutional support systems such as NIESBUD, TIIC, and MSME to demonstrate their relevance in fostering entrepreneurship development.
5. Create a comprehensive and viable business plan by integrating marketing, production, financial, and HR components along with regulatory and feasibility considerations.

Articulation Matrix

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

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

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.

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Apply the understanding of religious and cultural diversity to promote national integration and harmony
2. Build self-confidence, professional behavior, and interpersonal effectiveness through leadership and personality development skills.
3. Develop a spirit of selfless social service and civic responsibility for societal well-being.
4. Implement physical and mental wellness practices to enhance personal discipline and communication effectiveness.
5. Analyze the roles, structure, and leadership responsibilities in the Indian Armed Forces and NCC for contributing to national security and service.

Articulation Matrix

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

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga- Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Army, navy, Air force and Central armed policed forces- Modes of entry into army, police and CAPF- Naval expeditions & campaigns. History, Geography of Border / Coastal areas. EEZ maritime security & ICG. Modes of Entries in armed forces. Security challenges & role of cadets in Border management.

Aims, Objectives and org of NCC- Incentives- Duties of NCC cadets- NCC Camps: types and conduct.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

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. Apply CAD modeling techniques (wireframe, surface, and solid modeling) to design mechanical components using Constructive Solid Geometry (CSG) and Boundary Representation (B-rep) methods.
2. Analyze CNC machine operations and formulate G-code programs for turning and milling operations using linear and circular interpolation.
3. Develop an understanding of additive manufacturing (AM) processes and analyse their advantages over traditional CNC machining.
4. Design and develop 3D models for AM by converting CAD files into STL format, verifying and repairing them for defect-free part fabrication.
5. Analyze different AM systems and apply them in reverse engineering, medical, automotive, aerospace, and electronics industries.

Articulation Matrix

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

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

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.

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

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

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

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

Course Outcomes (COs)

1. Apply industrial engineering principles to select suitable plant layouts for the given production systems.
2. Analyze process planning and production control methods to improve scheduling, routing, and resource utilization in manufacturing systems.
3. Investigate work systems and ergonomics to identify optimize human-machine interactions.
4. Develop inventory models and material handling layouts to enhance production flow and reduce operational costs.
5. Design system-level strategies by integrating maintenance practices to ensure reliability and continuity in industrial operations.

Articulation Matrix

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

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

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.

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

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

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

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

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

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

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

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

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

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

PSO1. 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. Apply maintenance planning principles to develop cost-effective maintenance strategies, measurable through a maintenance plan.
2. Analyze maintenance categories and implement preventive maintenance schedules with lubrication methods.
3. Investigate condition monitoring techniques to validate equipment health using noise and vibration measurements.
4. Formulate failure analysis procedures using Non-Destructive Testing to design repair methods for mechanical components.
5. Develop a computer-aided maintenance management system (CAMMS) to integrate spare parts inventory and performance reporting.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

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.

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

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

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

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

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

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

PSO1. 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.

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Course Outcomes (COs)

1. Analyze the accident causation models and safety performance indices, to develop effective job safety analysis and accident investigation techniques.
2. Design the compliant safety and health frameworks for industrial operations, by analyzing the Factory Act 1948 and Tamil Nadu Factories Rules.
3. Apply the machine guarding principles and personal protective equipment standards, to develop safety protocols for metalworking and inspection processes.
4. Interpret the HAZOP study and safety valve principles, to design safe process systems and emergency plans for chemical plant operations.
5. Develop safety strategies for high-rise building, excavation, and confined space work, by analyzing construction hazards and regulations.

Articulation Matrix

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

UNIT I **9 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **9 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III **9 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop,- Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **9 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.