

B.E. (Mechanical Engineering)

2018 Regulations, Curriculum & Syllabi



BANNARI AMMAN INSTITUTE OF TECHNOLOGY

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

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VISION OF THE DEPARTMENT

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)

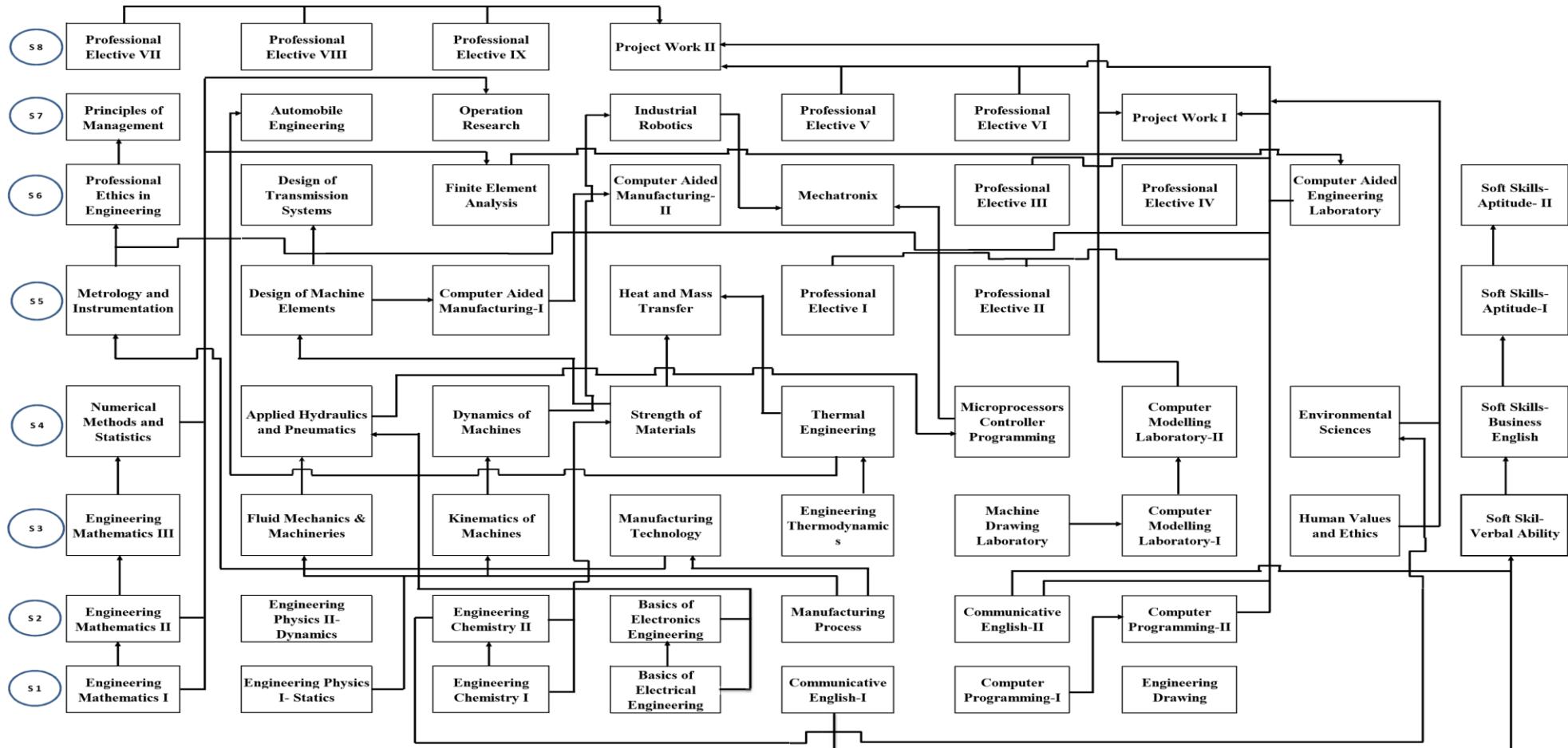
1. Design, analyse and evaluate the performance of mechanical systems.
2. Choose the appropriate methodology, materials, tools and machinery to manufacture quality products at affordable cost
3. Address all the fluid flow and energy transfer related problems of mechanical systems.

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	X
PEO II	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PEO III	X	X	X	X	X	X	X	X				X	X	X	X

DEPARTMENT OF MECHANICAL ENGINEERING
CURRICULAM DESIGN & INTERLINKING OF COURSES

360 ° FLEXIBLE LEARNING
FRAME WORK



DEPARTMENT OF MECHANICAL ENGINEERING - R2018										
Minimum Credits to be Earned : 170										
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	50	50	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	50	50	100	BS
18ME202	ENGINEERING PHYSICS II - DYNAMICS	2	1	0	3	3	50	50	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	50	50	100	BS
18ME302	FLUID MECHANICS AND MACHINERY	2	1	2	4	5	50	50	100	ES
18ME303	ENGINEERING THERMODYNAMICS	3	1	0	4	4	50	50	100	ES
18ME304	MANUFACTURING TECHNOLOGY	2	0	2	3	4	50	50	100	PC
18ME305	KINEMATICS OF MACHINES	3	1	0	4	4	50	50	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	50	50	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	-	-	-	-

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18ME501	METROLOGY AND INSTRUMENTATION	2	0	2	3	4	50	50	100	PC
18ME502	DESIGN OF MACHINE ELEMENTS	3	1	0	4	4	50	50	100	PC
18ME503	COMPUTER AIDED MANUFACTURING I	2	0	2	3	4	50	50	100	PC
18ME504	HEAT AND MASS TRANSFER	3	1	2	5	6	50	50	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	50	50	100	PE
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		16	2	8	21	26	-	-	-	-

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18HS002	PROFESSIONAL ETHICS IN ENGINEERING	2	0	0	2	2	50	50	100	HSS
18ME602	MECHATRONICS	2	0	2	3	4	50	50	100	PC
18ME603	FINITE ELEMENT ANALYSIS	3	1	0	4	4	50	50	100	PC
18ME604	DESIGN OF TRANSMISSION SYSTEMS	3	1	0	4	4	50	50	100	PC
18ME605	COMPUTER AIDED MANUFACTURING II	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	50	50	100	PE
18ME608	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	24	30	-	-	-	-

Code No.	Course	VII SEMESTER							Category	
		L	T	P	C	Hours/ Week	Maximum Marks			
							CIA	SEE	Total	
18HS003	PRINCIPLES OF MANAGEMENT	2	0	0	2	2	50	50	100	HSS
18ME702	AUTOMOBILE ENGINEERING	3	0	0	3	3	50	50	100	PC
18ME703	OPERATIONS RESEARCH	3	1	0	4	4	50	50	100	PC
18ME704	INDUSTRIAL ROBOTICS	2	0	2	3	4	50	50	100	PC
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	50	50	100	PE
18ME707	PROJECT WORK I	0	0	6	3	6	50	50	100	EEC
Total		17	1	8	21	25	-	-	-	-
VIII SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	SEE	Total	
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	50	50	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	50	50	100	PE
18ME804	PROJECT WORK II	0	0	18	9	18	50	50	100	EEC
Total		0	0	18	18	27	-	-	-	-

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
PHYSICS ELECTIVES										
18GE0P1	NANOMATERIALS SCIENCE	3	0	0	3	3	50	50	100	BS
18GE0P2	SEMICONDUCTOR PHYSICS AND DEVICES	3	0	0	3	3	50	50	100	BS
18GE0P3	APPLIED LASER SCIENCE	3	0	0	3	3	50	50	100	BS
CHEMISTRY ELECTIVES										
18GE0C1	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	50	50	100	BS
18GE0C2	ENERGY STORING DEVICES	3	0	0	3	3	50	50	100	BS
18GE0C3	POLYMER SCIENCE	3	0	0	3	3	50	50	100	BS
MATHEMATICS ELECTIVES										
18GE0M1	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	50	50	100	BS
18GE0M2	ALGEBRA AND NUMBER THEORY	3	0	0	3	3	50	50	100	BS
18GE0M3	MATHEMATICAL FINANCE AND QUEUEING THEORY	3	0	0	3	3	50	50	100	BS
DISCIPLINE ELECTIVES										
18ME001	COMPUTER AIDED DESIGN	3	0	0	3	3	50	50	100	PE
18ME002	DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	3	0	0	3	3	50	50	100	PE
18ME003	NON - TRADITIONAL MACHINING PROCESSES	3	0	0	3	3	50	50	100	PE
18ME004	WELDING TECHNOLOGY	3	0	0	3	3	50	50	100	PE
18ME005	ADVANCED STRENGTH OF MATERIALS	3	0	0	3	3	50	50	100	PE
18ME006	PROCESS PLANNING AND COST ESTIMATION	3	0	0	3	3	50	50	100	PE
18ME007	INTERNAL COMBUSTION ENGINES	3	0	0	3	3	50	50	100	PE
18ME008	REFRIGERATION AND AIR CONDITIONING	3	0	0	3	3	50	50	100	PE

18ME009	COMPOSITE MATERIALS	3	0	0	3	3	50	50	100	PE
18ME010	STATISTICAL QUALITY CONTROL AND RELIABILITY ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME011	MECHANICAL VIBRATIONS	3	0	0	3	3	50	50	100	PE
18ME012	SUPPLY CHAIN MANAGEMENT	3	0	0	3	3	50	50	100	PE
18ME013	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME014	ADVANCED CASTING AND FORMING PROCESSES	3	0	0	3	3	50	50	100	PE
18ME015	INDUSTRIAL SAFETY ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME016	ADDITIVE MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME017	NON-DESTRUCTIVE TESTING	3	0	0	3	3	50	50	100	PE
18ME018	RENEWABLE ENERGY SOURCES	3	0	0	3	3	50	50	100	PE
18ME019	CRYOGENIC ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME020	ENGINEERING TRIBOLOGY	3	0	0	3	3	50	50	100	PE
18ME021	POWER PLANT ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME022	OPTIMIZATION TECHNIQUES	3	0	0	3	3	50	50	100	PE
18ME023	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	3	3	50	50	100	PE
18ME024	INDUSTRIAL ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME025	INDUSTRIAL MAINTENANCE ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME026	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	3	50	50	100	PE
18ME027	FUELS AND COMBUSTION	3	0	0	3	3	50	50	100	PE
18ME028	PRODUCTION AND OPERATIONS MANAGEMENT	3	0	0	3	3	50	50	100	PE
18ME029	GREEN MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME030	PRODUCT DEVELOPMENT AND REVERSE ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME031	NANOMATERIALS AND NANOTECHNOLOGY	3	0	0	3	3	50	50	100	PE
18ME032	TOTAL QUALITY MANAGEMENT	3	0	0	3	3	50	50	100	PE
ENTREPRENEURSHIP ELECTIVES										
18GE0E1	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	50	50	100	PE
18GE0E2	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	50	50	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 AUDITING 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
ADDITIONAL ONE CREDIT COURSES										
18GE0XA	ETYMOLOGY	1	0	0	1	-	100	0	100	EEC
18GE0XB	GENERAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC

18GE0XC	NEURO BEHAVIORAL SCIENCE	1	0	0	1	-	100	0	100	EEC
18GE0XD	VISUAL MEDIA AND FILM MAKING	1	0	0	1	-	100	0	100	EEC
18GE0XE	YOGA FOR HUMAN EXCELLENCE	1	0	0	1	-	100	0	100	EEC
18GE0XF	VEDIC MATHEMATICS	1	0	0	1	-	100	0	100	EEC
18GE0XG	HEALTH AND FITNESS	1	0	0	1	-	100	0	100	EEC
18GE0XH	CONCEPT, METHODOLOGY AND APPLICATIONS OF VERMICOMPOSTING	1	0	0	1	-	100	0	100	EEC
18GE0XI	BLOG WRITING	1	0	0	1	-	100	0	100	EEC
18GE0XJ	INTERPERSONAL SKILLS	1	0	0	1	-	100	0	100	EEC
18GE0XK	COMMUNITY SERVICE AND LEADERSHIP	1	0	0	1	-	100	0	100	EEC
18GE0XL	NATIONAL CADET CORPS	1	0	0	1	-	100	0	100	EEC
18GE0XM	NEW AGE INNOVATION AND ENTREPRENEURSHIP	1	0	0	1	-	100	0	100	EEC
18GE0XN	DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES	1	0	0	1	-	100	0	100	EEC
18GE0XO	SOCIAL PSYCHOLOGY	1	0	0	1	-	100	0	100	EEC

OPEN ELECTIVES (Not for MECHANICAL Students)

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CIA	SEE	Total	
18ME0YA	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME0YB	SAFETY ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME0YC	MAINTENANCE ENGINEERING	3	0	0	3	3	50	50	100	PE
18ME0YD	BASICS OF NON-DESTRUCTIVE TESTING	3	0	0	3	3	50	50	100	PE
18ME0YE	DIGITAL MANUFACTURING	3	0	0	3	3	50	50	100	PE
18ME0YF	WORK STUDY AND ERGONOMICS	3	0	0	3	3	50	50	100	PE
18ME0YG	METROLOGY IN INDUSTRY	3	0	0	3	3	50	50	100	PE
18ME0YH	PLANT LAYOUT AND MATERIAL HANDLING	3	0	0	3	3	50	50	100	PE
18ME0YI	CONCEPTS OF ENGINEERING DESIGN	3	0	0	3	3	50	50	100	PE
18ME0YJ	OIL HYDRAULICS AND PNEUMATICS	3	0	0	3	3	50	50	100	PE
18ME0YK	ENERGY AUDITING AND MANAGEMENT	3	0	0	3	3	50	50	100	PE
18ME0YL	LEAN SIX SIGMA	3	0	0	3	3	50	50	100	PE
18ME0YM	HEATING VENTILATION AND AIR CONDITIONING	3	0	0	3	3	50	50	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	16%	15%	20%
2	ES	7	5	8	3	-	-	-	-	23	14%	15%	20%
3	HSS	2	2	-	-	-	2	2	-	8	5%	5%	10%
4	PC	-	3	9	15	15	16	10	-	68	40%	30%	40%
5	PE	-	-	-	-	6	6	6	9	27	15%	10%	15%
6	EEC	-	-	2	2	-	-	3	9	16	10%	10%	15%
Total		19	20	23	24	21	24	21	18	170	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

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)

- Apply the concepts of complex numbers, vectors, and matrices to solve engineering and mathematical problems.
- Interpret the application of limits, continuity, differentiation, and integration to solve various engineering problems
- Assess the various integration techniques, including substitution, integration by parts, and partial fractions, to solve application-based problems involving algebraic and transcendental functions.
- 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.
- 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.

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
FRICITION	
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 Lami's 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.Hibbeler, Engineering Mechanics: Combined Statics & Dynamics, Prentice Hall, 2009
5. D. P. Sharma, Engineering Mechanics, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2010.
6. S. Rajasekaran and G. Sankara subramanian, Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt. Ltd., New Delhi, 2005

18ME103 ENGINEERING CHEMISTRY I**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) & 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, Materials Science and Engineering, Prentice Hall of India, Delhi, 2009.
4. P. C. Jain and Monica Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publisher, New Delhi, 2016.
5. SashiChawla, Text Book of Engineering Chemistry, DhanpatRai Publications, New Delhi, 2013.
6. J. C. Kuriacose and J. Rajaram, Chemistry in Engineering & Technology, Vol. 1&2, TMH, 2009.

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

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

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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)	
<ol style="list-style-type: none">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

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)

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

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.

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, CHARACTERISTICS AND APPLICATION OF POLYMERS

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

UNIT IV **7 Hours**

ENGINEERING MATERIALS

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

UNIT V **5 Hours**

ADVANCED MATERIALS

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

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

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

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 Strings and exception handling.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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

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 2 π -Dirichlets conditions - sum of Fourier series- Theorem for the convergence of Fourier series (statement only)- Fourier series of a function with its periodic extension - Half range Fourier series: construction of half range sine series, construction of half range cosine series. Parsevals identity (statement only).

UNIT II	9 Hours
APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	
Classification of partial differential equations of second order-solution of: one dimensional wave equation, one dimensional heat equation, two dimensional heat equation and vibration of circular membrane.	
UNIT III	9 Hours
LAPLACE TRANSFORM	
Laplace Transform: Applications, advantages and sufficient conditions for existence of Laplace transform- general properties of Laplace transform-Laplace transform of periodic function. Inverse Laplace Transform: general properties of inverse Laplace transform - use of partial fraction method to find of inverse Laplace transform - convolution -application of Laplace transform to differential equations with constant coefficients.	
UNIT IV	9 Hours
PROBABILITY THEORY	
Probability: Classical definition and its limitations- axiomatic definition-some elementary deduction-frequency interpretation of probability -addition rule for 2 events (proof) and its extension to more than 2 events (statement only)- conditional probability and independent events -extension to more than 2 events (pairwise and mutual independence)- multiplication rule-Bayes theorem (statement only). Random variables: Definition of random variable- continuous and discrete random variables- probability density function & probability mass function for single variable only- distribution function and its properties (without proof)- definitions of expectation and variance, properties- some important discrete distributions: Binomial & Poisson distributions.	
UNIT V	9 Hours
MATHEMATICAL STATISTICS	
Population and sample - Sampling distributions. Statistical estimation of parameters, confidence intervals. Testing of hypotheses - one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.	
Tutorial: 15 Hours	
Total: 60 Hours	

Reference(s)

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

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/>.

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 (SFE), Application of SFE-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)	
<ol style="list-style-type: none">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	-	52	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)	
<ol style="list-style-type: none">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, 20134. 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	

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
FRICITION 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)	
<ol style="list-style-type: none">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, 20113. 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 Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2012
3. N.D. Bhatt, Machine Drawing, Charotar Publishing House Pvt. Ltd., 2014
4. K.R. Gopalakrishna, Machine Drawing, Subash stores, 20th edition, 2012
5. <https://nptel.ac.in/syllabus/112106075/>

**18ME307 COMPUTER AIDED MODELLING
LABORATORY I**

0 0 4 2

Course Objectives

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

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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-point arithmetic - propagation of errors. Numerical solution of algebraic equations: Bisection method - Regula-Falsi method - Newton-Raphson method. Numerical solution of a system of linear equations: Gauss elimination method - Matrix inversion- LU Factorization method - Gauss-Seidel iterative method

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

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

UNIT III	9 Hours
NUMERICAL DIFFERENTIATION	
Numerical single and double integration: Trapezoidal rule- Simpsons 1/3 rule - Expression for corresponding error terms.	
UNIT IV	
9 Hours	
NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION	
Numerical solution of ordinary differential equation: Eulers method - Runge-Kutta methods- Milnes Predictor-Corrector methods- Adams Predictor-Corrector methods - Finite Difference method.	
UNIT V	9 Hours
NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION	
Finite difference solution of parabolic equations by Crank-Nicholson method-elliptic equations by iterative methods-hyperbolic equations by explicit finite difference method.	
Tutorial: 15 Hours	
Total: 60 Hours	

Reference(s)

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

18ME402 APPLIED HYDRAULICS AND PNEUMATICS**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. Soundarajan, 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-sensitivity, Hunting, Ichoronism, Stability. Gyroscope- Gyroscopic effect, gyroscopic couple, gyroscopic effect on aero planes and naval ships.	
UNIT IV	6 Hours
FUNDAMENTALS OF VIBRATION	
Introduction-Terminology, Classification, elements of vibration, free undamped vibration, Free Damped vibration (Viscous 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>

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

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_eel1/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

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

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

18ME501 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.

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 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.	10 Hours
UNIT II DESIGN OF SHAFTS AND COUPLINGS Design of shafts based on strength, rigidity and critical speed. Design of rigid flange coupling -Design of flexible coupling.	10 Hours
UNIT III 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.	9 Hours
UNIT IV 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.	8 Hours
UNIT V DESIGN OF BEARINGS Types and selection criteria - Design of journal bearings - Design of rolling contact bearing - Ball and roller bearing.	8 Hours
	Tutorial: 15 Hours
	Total: 60 Hours
Reference(s)	
<ol style="list-style-type: none">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, 20113. 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, 20066. Faculty of Mechanical Engineering, PSG College of Technology, Design Data Book, M/s.Kalai kathir Achchagam, 2013.	

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

18ME504 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)

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

18HS002 PROFESSIONAL ETHICS IN ENGINEERING

2 0 0 2

Course Objectives

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

Programme Outcomes (POs)

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

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

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

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

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

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

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

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 moral and ethical characteristics of professionals in relation to respecting human values in the workplace.
2. Assess the professionalism of engineers through moral development theories and established codes of ethics.
3. Investigate risk factors through the study of historical industrial and technological disasters, and examine the ethical responsibilities of engineers as experimenters
4. Interpret workplace responsibilities and rights to support and uphold the fundamental rights of employees and professionals
5. Analyze the environmental, computer, and internet ethics that engineers should follow to address global challenges.

Articulation Matrix

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

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

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

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

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

UNIT III**6 Hours****ENGINEERING AS SOCIAL EXPERIMENTATION**

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

UNIT IV**6 Hours****WORKPLACE RESPONSIBILITIES AND RIGHTS**

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

UNIT V**6 Hours****GLOBAL ISSUES**

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

FOR FURTHER READING

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

Total: 30 Hours

Reference(s)

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

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**

Interfacing Encoder with microcontroller to measure position of DC motor

EXPERIMENT 3 **3 Hours**

Programming microcontroller to control the position of servo motor

EXPERIMENT 4 **3 Hours**

Design and simulation of pneumatic circuit using fluidsim software.

EXPERIMENT 5	3 Hours
Design and simulation of PID controller for mechatronics system in MATLAB.	
EXPERIMENT 6	3 Hours
Design and development of temperature control system using microcontroller	
EXPERIMENT 7	3 Hours
Programming microcontroller for speed control of stepper motor.	
EXPERIMENT 8	3 Hours
Programming microcontroller for speed control of DC motor.	
EXPERIMENT 9	3 Hours
Design and simulation of double acting cylinder circuit using PLC.	
EXPERIMENT 10	3 Hours
Design and simulation of meter-in and meter-out circuit in Fluidsim.	

Total: 60 Hours

Reference(s)

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

18ME603 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

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

18ME604 DESIGN OF TRANSMISSION SYSTEMS**3 1 0 4****Course Objectives**

- To study the design procedure of belt and rope drive
- To learn the design procedure of spur and helical gear drives
- To learn the design procedure of bevel and worm gear drives
- To study the design procedure of multistage gear box
- To familiarize the students for design of I.C. Engine Components

Programme Outcomes (POs)

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

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

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

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. Apply the design principles to identify the specifications of flexible power transmission elements such as belts and wire ropes.
2. Design spur and helical gear through force analysis, stress evaluation, and failure criteria for power transmission applications.
3. Interpret the bevel and worm gear systems based on the geometry of gear, type of loading, and failure modes for efficient power transmission.
4. Develop the step ratio, kinematic arrangement, ray diagram, and gear teeth specifications for the design of multistage gearboxes employed in industrial applications.
5. Analyze the design of motion-converting mechanisms and internal combustion engine components, such as pistons and connecting rods, by applying fundamental design concepts.

Articulation Matrix

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

UNIT I**9 Hours****DESIGN OF FLEXIBLE ELEMENTS**

Need for power transmission - Types and classification of transmission systems, Applications, Limitations.

Belt drives - Types, materials and construction, Selection of flat and V-belts from manufacturer's catalogue.

Wire Ropes- Construction, Rope lay, Stresses in wire rope, Failure of ropes.

UNIT II **9 Hours**

DESIGN OF SPUR AND HELICAL GEARS

Spur and Helical gears- Introduction, Gear design, Force analysis, Tooth stresses - Failure in gears.

UNIT III **9 Hours**

DESIGN OF BEVEL AND WORM GEARS

Bevel Gear- Introduction, Types, Geometry, Angle relations, Basic dimensions, Force analysis.

Worm Gear -Introduction, Types, Geometry, Basic dimensions - Forces on worm and worm wheel - Modes of failures.

UNIT IV **9 Hours**

DESIGN OF GEAR BOXES

Gear Box - Geometric progression - Standard step ratio - Ray diagram - Kinematics layout. Design of multi stage gear boxes, Calculation of number of teeth and overlapping speed.

UNIT V **9 Hours**

DESIGN OF MECHANISMS AND I.C. ENGINE COMPONENTS

Design of Ratchet & pawl mechanism and Geneva mechanism. Design of I.C engines components such as piston and connecting rod.

Tutorial: 15 Hours

Total: 60 Hours

Reference(s)

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2017.
2. R. L. Norton, Design of Machinery, Fifth Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2013.
3. T. J. Prabhu, Design of Transmission Elements, Mani Offset, Chennai, 2015.
4. B. J. Hamrock, B. Jacobson and S. R. Schmid, Fundamentals of Machine Elements, Third Edition, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2014.
5. S. G. Kulkarni, Machine Design, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2010.

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 processor.

UNIT V **6 Hours****MACRO PROGRAMMING AND ADVANCED LEARNING**

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

EXPERIMENT 1 **5 Hours**

Simulation and NC part program generation on linear and circular interpolation

EXPERIMENT 2 **5 Hours**

Simulation and NC part program generation on contour milling

EXPERIMENT 3 **5 Hours**

Simulation and NC part program generation on drilling and peck drilling

EXPERIMENT 4

5 Hours

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

EXPERIMENT 5

10 Hours

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

Total: 60 Hours

Reference(s)

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

**18ME608 COMPUTER AIDED ENGINEERING
LABORATORY**

0 0 4 2

Course Objectives

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

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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 axisymmetric 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**4 Hours**

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

EXPERIMENT 2**4 Hours**

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

EXPERIMENT 3**4 Hours**

Analysis of cantilever beam, simply supported beam and fixed beam under different boundary and loading conditions

EXPERIMENT 4**4 Hours**

Analysis of corner angular plate with holes for the determination of Von mises stress and maximum deformation under static loading with one hole fixed and the other hole pressure loaded.

EXPERIMENT 5**4 Hours**

Determination of Von mises stress and the maximum deformation that occur when a steel plate with holes is loaded as shown. The plate is constrained in y direction at bottom section and distributed load of 20 N pulling in the y-direction. The plate is made of steel with a Youngs modulus of 20×10^4 N/mm² and the Poissons ratio of 0.3.

EXPERIMENT 6**4 Hours**

Analysis of a compound bar under compression.

EXPERIMENT 7**4 Hours**

Stress analysis of a thin plate with hole with uniform load along any one direction in plane stress.

EXPERIMENT 8**4 Hours**

Analysis of a long cylindrical pressure vessel under plane strain.

EXPERIMENT 9**4 Hours**

Analysis of shaft subjected to twisting moments.

EXPERIMENT 10**4 Hours**

To solve a simple buckling problem to determine the deflection and reaction forces.

EXPERIMENT 11	4 Hours
Modal analysis of Cantilever, Simply supported and Fixed beams under different boundary conditions	
EXPERIMENT 12	4 Hours
Developing Design Guidelines to Prevent Buckling Failures in Structural Element of a bridge.	
EXPERIMENT 13	4 Hours
Temperature distribution in circular and radial fins.	
EXPERIMENT 14	4 Hours
Temperature distribution in 2D and 3 D components under different boundary conditions for a heat conduction analysis.	
EXPERIMENT 15	4 Hours
Coupled temperature and stress analysis of a compound object to determine the thermal stresses.	

Total: 60 Hours

Reference(s)

1. Srinivasan, K. C. Sambana and 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)

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

Articulation Matrix

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

18HS003 PRINCIPLES OF MANAGEMENT**2 0 0 2****Course Objectives**

- To develop cognizance about importance of management principles.
- To extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- To learn the application of the theories in an organization.
- To 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**6 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	6 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	6 Hours
ORGANIZING	
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	6 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	6 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: 30 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.

18ME702 AUTOMOBILE ENGINEERING**3 0 0 3****Course Objectives**

- To impart knowledge on the constructional details and principle of operation of various automobile components.
- To provide knowledge on the working of fuel supply and engine auxiliary system in various automobiles.
- To learn the function of various components in transmission and drive lines of a vehicle.
- To study the concept and working of steering, brakes and suspension systems in automobile.
- To impart knowledge on electrical and electronic systems of automobiles.

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs)

1. Demonstrate the operating principles and constructional 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 various types of steering, suspension, and braking systems used in automobiles.
5. Analyze the operation of automotive electrical and electronic systems with reference to vehicle functionality

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	3	-	2	-	1	1	-	-	-	-	1	-	2	-

UNIT I**9 Hours****VEHICLE STRUCTURE AND ENGINES**

Types of Automobiles - vehicle construction, chassis, frame and body. Vehicle aerodynamics (various resistances and moments involved). Engine -Types and Construction. Lubrication system - Types and construction. Cooling system -Types and construction.

UNIT II **9 Hours**

FUEL SUPPLY AND ENGINE AUXILIARY 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. Engines Supercharger, turbo charger, engine emission control by 3 Way catalytic controller. Emission norms (Euro and BS)

UNIT III **9 Hours**

TRANSMISSION AND DRIVE LINES

Clutch- Types- single plate clutch, multi plate clutch. Gearbox - Types- synchromesh gearbox, sliding mesh gear box, constant mesh gearbox. Automatic transmission system. Fluid flywheel, torque convertors, propeller shaft, slip joint, universal Joints, differential and rear axle drives - hotchkiss drive and torque tube drive.

UNIT IV **9 Hours**

STEERING, BRAKES AND SUSPENSION

Wheels and Tyre Construction. Steering geometry and types of steering - rack and pinion steering gear, recirculating ball type steering gear and Power steering - construction and working principle. Suspension systems - Types - rear suspension and front suspension. Braking systems-Types- disc brake, drum brake, hydraulic brake and air brake.

UNIT V **9 Hours**

ELECTRICAL AND ELECTRONIC SYSTEMS

Electrical systems, battery types, construction and working principle of lead acid battery. Generator, starting motor and drives. Lighting, ignition (Battery, Magneto Coil and Electronic type), regulators, cut outs. Different electronic control unit used in the engine management, block diagram of the engine management system. IoT in automobiles and its application.

FOR FURTHER READING

Active Suspension System (ASS), Electronic Brake Distribution (EBD), 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.

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
QUEUEING MODELS	
Queueing model - Introduction , Elements, Kendall's Notation, Parameters, Single Server and multi-server models, Poisson input, Exponential service, Constant rate service, Finite and Infinite population.	
UNIT V	9 Hours
SEQUENCING AND REPLACEMENT MODEL	
Sequencing Problem - Introduction, Types - n jobs with 2 machines and n jobs with 3 machines. Replacement Models - Introduction, Types, Replacement of items that deteriorate with time, Value of money changing with time and not changing with time, Optimum replacement policy - Individual and Group replacement policy.	
	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.

18ME704 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 effector commands, and Simple programs.

UNIT V **6 Hours****IMPLEMENTATION AND APPLICATION**

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

EXPERIMENT 1 **3 Hours**

Study of various types of robots.

EXPERIMENT 2 **3 Hours**

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

EXPERIMENT 3	3 Hours
Identification of various component in pneumatic and hydraulic drive system	
EXPERIMENT 4	3 Hours
Automating the operation of a machine vice according to specified need using pilot valves.	
EXPERIMENT 5	3 Hours
Load cell measurement	
EXPERIMENT 6	3 Hours
Displacement measurement using LVDT	
EXPERIMENT 7	3 Hours
Forward and Inverse Kinematics: The forward and inverse kinematics of the SCARA robot are derived and calculated in a simulation software.	
EXPERIMENT 8	3 Hours
Offline Programming: The previously modelled SCARA robot is then programmed offline, also using the industrial robot simulation system.	
EXPERIMENT 9	3 Hours
Programming a parallel kinematic robot for a pick and place application	
EXPERIMENT 10	3 Hours
Programming the robot for a drilling application	
Total: 60 Hours	

Reference(s)

1. M. P. Groover, Industrial Robotics Technology, Programming and Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2nd Edition, 2012.
2. D. Richard, Klafter, A. Thomas, Chmielewski and Michael Negin, Robotics Engineering, An Integrated Approach, Prentice Hall of India, New Delhi, 2010.
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2003
4. Yoram Koren, Robotics for Engineers, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 2004.
5. James G. Keramas, Robot Technology Fundamentals, Cengage Learning, 2011.
6. <https://nptel.ac.in/courses/1121031>

18ME707 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

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	PSO3
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	PSO3
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 & Distributors Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber München, 2007.

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	PSO3
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.

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	PSO3
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	PSO3
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 franÃ§aise, alphabets, les numÃ©ros, les jours, les mois. Grammaire Les verbes s appeler, etre, avoir, les articles definis, indefinis Communication Saluer, s informer sur quelqu un, demander de se presenter Lexique L alphabet, les nationalites, l age, les pays, les couleurs, les jours de la semaine, les mois de l annee, les professions

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

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

UNIT III	9 Hours
VIVRE AU QUOTIDIEN LES LOISIRS DES FRANCAIS, LES GOUTS DES AUTRES, LES ACTIVITES QUOTIDIENNES	
Grammaire Articles contractes, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses gouts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activites quotidiennes, le temps (le matin, le soir, la nuit)	
UNIT IV	9 Hours
COMPRENDRE SON ENVIRONNEMENT SOUVRIR A LA CULTURE	
Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, 1 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

18GE0P1 NANOMATERIALS SCIENCE**3 0 0 3****Course Objectives**

- To impart knowledge on Nanoscience.
- To explore different techniques of producing nanomaterials.
- To 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

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 fundamental principles of nanoscience to classify nanomaterials based on their structure and properties.
2. Analyse the five synthesis methods of nanomaterials by comparing their efficiency, scalability, and applicability.
3. Design nanomaterial-based solutions for applications in electronics, energy storage, and biomedical fields by evaluating their functional properties.
4. Investigate the structural, optical, and electronic properties of nanomaterials using techniques such as electron microscopy and spectroscopy.
5. Assess real-world applications of nanomaterials in emerging fields such as spintronics, MEMS/NEMS, and quantum computing, evaluating their performance.

Articulation Matrix

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

UNIT I**9 Hours****NANO SCALE MATERIALS**

Introduction - Feynman's vision-national nanotechnology initiative (NNI) - past, present, future - classification of nanostructures, nanoscale architecture - effects of the nanometer length scale - changes to the system total energy, and the system structures- effect of nanoscale dimensions on various properties - differences between bulk and nanomaterials and their physical properties.

UNIT II	9 Hours
NANOMATERIALS SYNTHESIS METHODS	
Top down processes - mechanical milling, nanolithography and types based on radiations - Bottom up process physical method: physical vapour deposition, RF sputtering, CVD- chemical method: colloidal and sol-gel methods - template based growth of nanomaterials - ordering of nanosystems, self-assembly and self-organization.	
UNIT III	9 Hours
CHARACTERIZATION TECHNIQUES	
General classification of characterization methods - analytical and imaging techniques - microscopy techniques - electron microscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy - diffraction techniques - X-ray spectroscopy - thermogravimetric analysis of nanomaterials.	
UNIT IV	9 Hours
SEMICONDUCTOR NANOSTRUCTURES	
Quantum confinement in semiconductor nanostructures - quantum wells, quantum wires, quantum dots, super lattices-epitaxial growth of nanostructures-MBE, metal organic VPE, LPE - carbon nano tubes-structure, synthesis and electrical properties -applications- quantum well laser- quantum efficiency of semiconductor nanomaterials.	
UNIT V	9 Hours
NANOMACHINES AND NANODEVICES	
Microelectromechanical systems (MEMS) and Nanoelectromechanical systems (NEMS)-fabrication, actuators-organic FET- principle, description, requirements, integrated circuits- single electron transistor - organic photovoltaic cells- spintronics.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">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.	

**18GE0P2 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

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. Assess the band gap, drift current, and diffusion current densities associated with carrier transport in semiconductors.
2. Analyze the energy band diagram in thermal equilibrium and the space charge width of a PN junction
3. Apply the operation of a Bipolar Junction Transistor at different modes and configurations.
4. Illustrate the principles of charge storage in floating-gate transistors for non-volatile memory applications
5. Investigate 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	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
2	2	1	-	-	-	-	-	-	-	-	-	1	-	-	-
3	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
4	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
5	2	1	2	2	-	-	-	-	-	-	-	1	-	-	-

UNIT I**9 Hours****ENERGY BANDS AND CARRIER TRANSPORT PROPERTIES**

Energy Bands: Formation of energy bands - doping effects - energy levels - electron and hole concept in semiconductor. Carrier transport: Carrier drift-drift current density - conductivity- diffusion current density - total current density.

UNIT II	9 Hours
P-N JUNCTION	
Basic structure and fabrication process of p-n junction - current - voltage characteristics - energy band diagram - equilibrium Fermi levels - depletion region - junction breakdown phenomena - zener - avalanche breakdown.	
UNIT III	9 Hours
BIPOLAR JUNCTION TRANSISTOR	
The basic transistor action - operation in the active mode - current gain - static characteristics - carrier distribution in emitter, base and collector region - modes of operation - current - voltage characteristics of common base and emitter configuration - frequency response and switching of bipolar transistor.	
UNIT IV	9 Hours
MOSFET	
The ideal MOS diode - basic fundamentals and characteristics - types - CMOS and BiCMOS - CMOS inverter - MOSFET on insulator - thin film transistor (TFT) - silicon on insulators (SOI) devices - MOS Memory structures - DRAM and SRAM.	
UNIT V	9 Hours
PHOTONIC DEVICES	
Radiative transitions and optical absorption-light emitting diodes-organic LED - infrared LED - semiconductor laser - temperature effect - photo detector - photo diode - silicon and compound semiconductor solar cells – efficiency.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">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.	

18GE0P3 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

Course Outcomes (COs)

1. Analyze the principles of light absorption and emission in lasers, applying Einstein's relations to understand the conditions for stimulated emission and light amplification
2. Assess the principles and applications of various laser types to evaluate their unique characteristics.
3. Apply laser technologies to evaluate their impact on scientific research and advancements.
4. Investigate the effectiveness and safety of laser therapies in medical applications.
5. Evaluate the efficiency of laser applications in material processing and industrial technologies.

Articulation Matrix

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

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 (CO ₂ 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)	
<ol style="list-style-type: none">1. K. Thiagarajan and A. K. Ghatak, "LASERS: Fundamentals and Applications", Springer, USA, 2015.2. M. N. Avadhanulu, "An Introduction to Lasers Theory and Applications", S. Chand Publisher, 2013.3. W. Koechner, M. Bass, "Solid State Lasers: a graduate text", Springer Verlag, New York, 2006.4. K. P. R. Nair, "Atoms, Molecules and Lasers", Narosa Publishing House, 2009.5. K. R. Nambiar, "Lasers: Principles Types and Applications", New Age International Publications, 2006.6. A. Sennaroglu, "Solid-State Lasers and Applications", CRC Press, 2006.	

18GE0C1 CORROSION SCIENCE AND ENGINEERING**3 0 0 3****Course Objectives**

- To analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion.
- To identify forms and types of corrosion with suitable mechanism.
- To 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.

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

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

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

Course Outcomes (COs)

1. Illustrate the 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. Interpret different corrosion types on metals when exposed to air, water and at high temperatures ($> 100^{\circ}\text{C}$)
3. Assess the mechanism of corrosion on steel, iron, zinc and copper metal surfaces
4. Investigate the corrosion rate of metals using electrochemical testing methods under defined environmental conditions
5. Analyze the suitable 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		-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-
3	3		-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-
5	3	3	-	-	-	-	1	-	-	-	-	-	-	-	-

UNIT I CORROSION Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals – Pourbaix diagrams of Mg, Al and Fe and their advantages and disadvantages.	9 Hours
UNIT II TYPES OF CORROSION Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion.	7 Hours
UNIT III 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.	9 Hours
UNIT IV 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.	10 Hours
UNIT V 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.	10 Hours
	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 .	

18GE0C2 ENERGY STORING DEVICES**3 0 0 3****Course Objectives**

- To compare the energy density of commercialized primary and secondary batteries.
- To classify the fuel cells and compare their efficiency in different environmental conditions.
- To demonstrate the various energy storage devices and fuel cells.

Programme Outcomes (POs)

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

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

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

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

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

Course Outcomes (COs)

1. Interpret the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Analyze the electrodes, electrolytes, and cell reactions of various primary and secondary batteries, and infer the selection criteria for commercial battery systems based on their application requirements.
3. Illustrate the fuel cells based on their construction, current production, and applications
4. Assess the methods of storing hydrogen fuel along with their environmental applications.
5. Investigate the future prospects of renewable energy, hydrogen economy, and the efficiency of various generations of solar cells in energy production.

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	-		-	-	-	-	-	-	-	-	-	-	-	-
5	2	2	2	2	-	-	1	-	-	-	-	-	-	-	-

UNIT I**6 Hours****BASICS OF CELLS AND BATTERIES**

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge.

UNIT II	10 Hours
BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES	
Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photo galvanic 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 - photo biochemical conversion cell.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">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, 20183. 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.	

18GE0C3 POLYMER SCIENCE**3 0 0 3****Course Objectives**

- To explain the properties of different polymers with its mechanism.
- To select the appropriate polymerization techniques to synthesize the polymers.
- To 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.
- PO4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
- PO7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Course Outcomes (COs)

1. Illustrate the various types of mechanisms involved in polymerization reactions, including initiation, propagation, termination, and chain transfer processes.
2. Implement and analyze the suitable polymerization techniques to synthesize high-quality polymers.
3. Assess the structural, thermal, and mechanical properties of polymers for diverse applications.
4. Investigate the polymer processing methods to design polymer products.
5. Interpret the polymers employed 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	-		-	-	-	-	-	-	-	-	-	-	-	-
2	1	-		-	-	-	-	-	-	-	-	-	-	-	-
3	2	-		-	-	-	-	-	-	-	-	-	-	-	-
4	1	1	2	2	-	-	-	-	-	-	-	-	-	-	-
5	1	-		-	-	-	1	-	-	-	-	-	-	-	-

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 - Vicat 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)	
<ol style="list-style-type: none">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.mcp.2019.119161.	

18GE0M1 GRAPH THEORY AND COMBINATORICS**3 0 0 3****Course Objectives**

- To comprehends the graph as a modeling and analysis tool in computer science & Engineering.
- To introduce 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

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

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

Course Outcomes (COs)

1. Apply the principles of graph theory, counting, and recurrence relations to solve problems in discrete mathematics and theoretical computer science.
2. Analyze graph structures, colorings, and connectivity properties to assess relationships and dependencies within discrete systems.
3. Investigate efficient combinatorial solutions using permutations, combinations, and generating functions to address complex counting and optimization problems.
4. Develop mathematical models involving planar graphs, matching, network flows, and recurrence relations for practical applications in computing and engineering.
5. Design models and strategies using Euler and Hamiltonian paths, chromatic polynomials, and generating functions through real-world examples and problem-solving scenarios.

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

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

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II	9 Hours
TREES, CONNECTIVITY	
Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.	
UNIT III	9 Hours
MATRICES, COLOURING AND DIRECTED GRAPH	
Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.	
UNIT IV	9 Hours
PERMUTATIONS	
Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.	
UNIT V	9 Hours
GENERATING FUNCTIONS	
Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. NarsinghDeo, 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.	

18GE0M2 ALGEBRA AND NUMBER THEORY**3 0 0 3****Course Objectives**

- Understand the basic notions of groups, rings, fields which will then be used to solve related problems.
- Examine the key questions in the Theory of Numbers.
- Implement the integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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)

- Apply the fundamental concepts of algebraic structures such as groups, rings, fields, and finite fields to solve problems in number theory and cryptography.
- Analyze polynomials over finite fields and factorization techniques to understand their role in modern algebra and coding theory.
- Investigate algorithms like Euclidean and base-b representation to solve problems involving divisibility, prime numbers, and canonical decompositions.
- Design mathematical models using Diophantine equations, congruences, and the Chinese Remainder Theorem to solve problems in modular arithmetic and system designs.
- Develop applications of classical number theory theorems such as Euler's, Fermat's, Wilson's and multiplicative functions in cryptography and number patterns.

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

UNIT I**9 Hours****FIELDS**

Group Theory - Rings and Polynomials - Fields.

UNIT II**9 Hours****FINITE FIELDS AND POLYNOMIALS**

Finite Fields - Irreducible Polynomials over Finite fields - Factorization of Polynomials over Finite Fields.

UNIT III	9 Hours
DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS	
Division algorithm- Base-b representations - number patterns - Prime and composite numbers - Fibonacci and Lucas numbers - Fermat numbers - GCD - Euclidean Algorithm - Fundamental theorem of Arithmetic - LCM.	
UNIT IV	
8 Hours	
DIOPHANTINE EQUATIONS AND CONGRUENCES	
Linear Diophantine equations - Congruence s - Linear Congruence s - Applications: Divisibility tests - Modular Designs - Chinese remainder theorem - 2x2 linear systems.	
UNIT V	10 Hours
CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS	
Wilson s theorem - Fermat s Little theorem - Euler s theorem - Euler s Phi functions - Tau and Sigma functions - Perfect numbers - Mersenne Primes - Mobius Function.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Lidl.R., and Pilz. G., Applied Abstract Algebra, Springer-Verlag, New Delhi, 2nd Edition, 2006.2. Thomas Koshy, Elementary Number Theory with Applications, Elsevier Publications, New Delhi, 2002.3. San Ling and Chaoping Xing, Coding Theory: A first Course, Cambridge Publications, Cambridge, 2004.4. Niven.I, Zuckerman.H.S., and Montgomery, H.L., An Introduction to Theory of Numbers, John Wiley and Sons, Singapore, 2004.	

**18GE0M3 MATHEMATICAL FINANCE AND
QUEUEING THEORY**
3 0 0 3
Course Objectives

- To provide the required fundamental concepts in probability and queueing models and apply these techniques in networks, image processing etc.
- Acquire skills in analyzing queueing 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.

Course Outcomes (COs)

1. Apply concepts of stochastic calculus, including Brownian motion, Ito integration, and the Feynman-Kac formula, to model random processes in continuous time.
2. Analyze statistical data using parameter estimation, regression techniques, hypothesis testing, and normality assessments with practical implementation in R.
3. Investigate the Black-Scholes-Merton framework for its application in derivative pricing, risk-neutral measures, and self-financing strategies.
4. Design and evaluate queuing models for Markovian and non-Markovian systems to assess system performance.
5. Develop simulations and case studies to analyze real-world applications of stochastic models and queueing theory in finance and operations research.

Articulation Matrix

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

UNIT I
9 Hours
APPLIED STOCHASTIC CALCULUS

Brownian motion - Constructions - Non-differentiability - Quadratic variation - Stochastic integration - Construction of Ito integral and properties, the Ito formula - Feynman-Kac formula

UNIT II
9 Hours
STATISTICS

Basic parameter estimation - Maximum likelihood estimation - Distributions - Regression techniques - Tests for normality - QQ plots - Hypothesis testing - Numerical examples in R.

UNIT III	9 Hours
CONTINUOUS-TIME FINANCE	
Black-Scholes-Merton model of stock prices as geometric Brownian motion, derivation of the Black-Scholes-Merton partial differential equation, the Black-Scholes formula and simple extensions of the model, self-financing strategies and model completeness, risk neutral measures, the fundamental theorems of asset pricing, continuous time optimal stopping and pricing of American options, forwards and futures in Black-Scholes-Merton model.	
UNIT IV	9 Hours
QUEUEING THEORY	
Markovian queues - Birth and Death processes - Single and multiple server queueing models - Little's formula - Queues with finite waiting rooms - Finite source models.	
UNIT V	9 Hours
NON-MARKOVIAN QUEUES AND QUEUEING NETWORKS	
M/G/1 queue - Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases - Series queues - Open and closed Jackson networks.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, Springer, 2005.2. S. Shreve, Stochastic Calculus for Finance, Vol. 1 and Vol. 2, Springer, 2004.3. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.4. Taha, H.A., Operations Research, Pearson Education, Asia, 8th Edition, 2007.	

18ME001 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.

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. Interpret two- and three-dimensional geometric transformations such as translation, scaling, rotation, and reflection to model engineering components in CAD systems.
2. Illustrate curve and surface modeling techniques, including Hermite, Bezier, B-spline, and rational representations, to infer their suitability for specific design scenarios.
3. Apply boundary representation and constructive solid geometry to create and validate accurate solid models for manufacturing prototypes.
4. Analyze assembly models to check fit, avoid interference, and ensure they work correctly by using tolerances and mass properties.
5. Evaluate the use of standard CAD data exchange formats like IGES, STEP, STL, and DXF for facilitating effective communication between CAD and CAM systems.

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

UNIT I

9 Hours

FUNDAMENTALS

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.

UNIT II

10 Hours

GEOMETRIC MODELING

Representation of curves - Hermite, Bezier, B-Spline and rational curves - Surface Modeling - surface patch - Bezier and B spline surface. Solid Modelling - Boundary representation and Constructive Solid Geometry

UNIT III

9 Hours

VISUAL REALISM

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 OF PARTS

Assembly modeling - Interference of Positions and orientations - CAD Tolerance Analysis - geometrical Mass Properties - degree of freedom - Constraints and Simulation concepts.

UNIT V

9 Hours

DATA EXCHANGE FORMATS

Database Management System - CAD Standards- File types - IGES, PDES, PARASOLID, ACIS, Data - Database - Structures - Types, DXF, STL and STEP Files. Communication Standards - File Transfer between CAD and CAM package.

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 EducationIndia, 2006.
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.

18ME002 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

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.

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 objectives, challenges, and design principles of jigs and fixtures, including fits, tolerances, and geometric dimensioning standards used in tool design.
2. Analyze various locating and clamping methods using the 3-2-1 principle to infer optimal configurations based on design constraints and degrees of freedom.
3. Design jigs for machining operations by integrating suitable elements like drill bushes, indexing mechanisms, and automation for increased efficiency and precision.
4. Develop fixture systems for milling, boring, grinding, and welding operations using modular design approaches and material selection principles.
5. Formulate press tool systems, including progressive and compound dies, by simulating blank development, strip layout, and calculating tonnage requirements for forming operations.

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

UNIT I **7 Hours****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 Tolerancing.

UNIT II **8 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 **10 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 **10 Hours****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 **10 Hours****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

18ME003 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 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 thermal energy-based machining processes such as LBM, EBM, and PAM for cutting hard-to-machine materials in advanced manufacturing applications

Articulation Matrix

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

UNIT I	7 Hours
NON-TRADITIONAL MACHINING PROCESS	
Introduction - Need - Classification - Energies employed in the processes - Brief overview of Abrasive jet machining (AJM), Water jet machining (WJM), Ultrasonic machining (USM), Electric discharge machining (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.	
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 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)	
<ol style="list-style-type: none">1. P. K. Mishra, Non Conventional Machining, Narosa Publishing House, New Delhi, 20072. P. C. Pandey and H.S.Shan, Modern Machining Processes, Tata McGraw Hill Publishing Company Pvt Ltd., New Delhi, 2008.3. Joao Paulo Davim, Nontraditional Machining Processes: Research Advances, Springer, New York, 2013.4. Paul De Garmo, J.T.Black, and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2011.5. Vijaya Kumar Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi, 2005.6. Hassan El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill Professional, New delhi, 2005	

18ME004 WELDING TECHNOLOGY**3 0 0 3****Course Objectives**

- To study the principles of welding process, gas welding, arc welding and their applications.
- To provide knowledge on resistance welding process, parameters and its applications.
- To study the solid-state welding process, parameters and its applications.
- To know about special welding process and the welding automation for mass production.
- To learn the welding metallurgy, design and testing of weldments.

Programme Outcomes (POs)

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

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

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

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

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 fundamental principles of gas and arc welding processes, including power sources, metal transfer modes, and types of weld joints, to select appropriate welding techniques for various materials and applications.
2. Analyze the working mechanisms, advantages, limitations, and applications of various resistance welding processes to evaluate their suitability for different industrial scenarios.
3. Apply knowledge of solid-state welding processes such as friction, diffusion, and ultrasonic welding to select appropriate processes based on joint requirements and material characteristics.
4. Apply special welding processes including thermit, electron beam, and underwater welding, and develop automation strategies for their implementation in aerospace, nuclear, and transport industries.
5. Design different types of weld joints using standard welding symbols and dimensions, and formulate proper welding procedures considering material weldability and mechanical requirements.

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

UNIT I	9 Hours
WELDING PRINCIPLES, 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. Gas welding: Oxyacetylene welding (OAW), Oxyhydrogen welding (OHW). Arc welding: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Tungsten Arc Welding (GTAW/TIG), Gas Metal Arc Welding (GMAW/MIG), Plasma Arc Welding (PAW) and Electroslag welding (ESW), Electro gas Welding process (EGW) - Advantages, limitations and its applications.	
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, Welding automation in aerospace, nuclear and surface transport vehicles.	
UNIT V	9 Hours
DESIGN OF WELD JOINTS, TESTING OF WELDMENTS, CODES AND STANDARDS	
Welding symbols, welding dimension, design of various welded joints Weldability of Aluminium, Copper, Cast Iron and Stainless steels. Destructive tests: Tensile Testing, Ductility Testing, Toughness Testing, Fatigue Testing. 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)	
<ol style="list-style-type: none">1. David H. Phillips, Welding Engineering: An Introduction, Wiley, 2016.2. Parmer R.S., Welding Engineering and Technology, 3rd edition, Khanna Publishers, New Delhi, 20153. 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, 2005.5. AWS Welding Hand Book, Welding Process, 9th Edition, Vol- 1&2, 2005.6. https://nptel.ac.in/courses/112107089/	

18ME005 ADVANCED STRENGTH OF MATERIALS**3 0 0 3****Course Objectives**

- To provide knowledge on deformation mechanisms in materials.
- To learn high temperature deformation phenomena.
- To impart knowledge on various fracture mechanism.
- To provide knowledge on the various strengthening mechanisms in materials.
- To impart knowledge on fatigue failure for different cyclic loading 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.

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 deformation and dislocation behaviour of materials subjected to loading
2. Apply the deformation behaviour in materials subjected to higher temperatures
3. Analyze the deformation behaviour in materials subjected to low temperatures and embrittlement
4. Analyze the working conditions to design appropriate strengthening mechanisms that enable materials to withstand operational stresses and environmental factors effectively.
5. Design the materials to inhibit crack initiation, withstand fracture and fatigue loading

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

UNIT I**9 Hours****BASIC CONCEPT OF MATERIAL BEHAVIOR**

Deformation - Types - Elastic deformation - Elastic modulus, linear elastic deformation- Rubber Elasticity, Elasticity -Plastic deformation, Yield strength of a perfect crystal, Dislocations - Edge, Screw and Mixed dislocation, Slip and Twinning, Interaction of moving dislocations.

UNIT II	9 Hours
HIGH TEMPERATURE DEFORMATION	
Creep mechanism - Dislocation glide at low temperature, Differential flow creep mechanisms - Creep in two phase alloys - Independent and sequential process -Deformation mechanism maps - Engineering aspects of creep design -Introduction to Super plasticity, Hot working of metals, Dynamic Recovery and recrystallization.	
UNIT III	9 Hours
TENSILE FRACTURE AT LOW TEMPERATURE AND EMBRITTLEMENT	
Theoretical strength of a crystalline solid - Types of low temperature tensile fracture (Mode I, Mode II, Mode III Brittle fracture) - Ductile fracture, Introduction to Embrittlement fracture and types - Characteristics of Liquid Metal Embrittlement (LME), Solid Metal Embrittlement (SME), Hydrogen Embrittlement (HE) and Stress Corrosion Cracking (SCC).	
UNIT IV	9 Hours
STRENGTHENING MECHANISMS	
Strengthening Mechanism-Types-Work hardening, Boundary strengthening, solid solution strengthening, Particle hardening- Deformation of two phase aggregates- Precipitation hardening in aluminum alloys, Patented steel wire, Martensite, Ausforming, TRIP (Transformation induced plasticity) steel, Maraging steel	
UNIT V	9 Hours
FRACTURE MECHANICS AND FATIGUE	
Importance of Fracture Mechanics, Griffith Fracture Theory-Crack Driving Force & Energy Release Rate-Stress intensity factors - Fracture Toughness - Crack initiation and propagation- Material design for fracture toughness- Characteristics of fatigue fracture - Fatigue crack growth rates - Par's Law - Cyclic stress-strain behavior - Design and evaluation of materials against fatigue.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Thomas H Courtney, Mechanical Behavior Materials, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 20002. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, New Delhi, 2000.3. M. A. Meyers and K. Chawla, Mechanical Behavior of Materials, Prentice Hall of India, New Delhi, 2001.4. George E. Dieter, Mechanical Metallurgy, Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi, 2007.5. F. A. Mcclintock, and A. S. Argon, Mechanical Behavior of Materials, Addison Wesley Reading , Mass, New Delhi, 1966.	

18ME006 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.

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 principles of process planning to select suitable machines, materials, and processes for manufacturing components.
2. Analyze various cost elements including direct, indirect, and overhead expenses involved in manufacturing operations.
3. Analyze various cost elements including direct, indirect, and overhead expenses involved in manufacturing operations.
4. Estimate machining time for operations like turning, drilling, boring, shaping, milling, and grinding with given process parameters
5. Analyze and compute the total production cost in forging, welding, and foundry operations using appropriate cost estimation techniques for accurate manufacturing planning.

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

UNIT I**9 Hours****PROCESS PLANNING**

Definition - Objective - Scope - Process planning activities - Approaches - Manual, Computer Aided Process planning - Retrieval, Generative and Semi- generative - Selection processes - Machine selection - Material selection parameters - Set of documents for process planning. Production time calculation - Selection of cost optimal processes.

UNIT II **8 Hours**

INTRODUCTION TO COST ESTIMATION

Objectives and functions of Estimating - Costing - Importance and aims of Costing - Difference between Costing and Estimation - Methods of Costing - Types of estimates - Methods of estimates - Importance of Realistic Estimates - Estimating procedure.

UNIT III **8 Hours**

ELEMENTS OF COST

Introduction - Material Cost - Direct and Indirect - Labour cost - Direct, Indirect and Determination of Direct Labour Cost - Expenses - Direct and Indirect - Analysis of overhead expenses - Administrative expenses - Selling and Distributing expenses - Allocation of overhead expenses- Depreciation - Causes and methods of depreciation.

UNIT IV **10 Hours**

PRODUCTION COST ESTIMATION

Estimation in forging shop - Losses in forging and forging cost - Problems - Estimation in Gas cutting and welding shop - Material cost, Labour cost and Finish on cost -Problems - Estimation in foundry shop - Pattern cost, Foundry cost and casting cost - Problems

UNIT V **10 Hours**

ESTIMATION OF MACHINING TIME

Importance of machine time calculations - Estimation of machining time for Lathe, drilling, boring, shaping, milling and grinding operations - Problems

FOR FURTHER READING

Case studies in Plant Layout design, Equipment selection, and process planning, Cost Evaluation of Layout - Implementation process.

Total: 45 Hours

Reference(s)

1. R. Kesavan, E.Elanchezhian, B.Vijaya Ramnath, Process planning and cost estimation, New Age International Publications, 2008
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, 2011
4. Peter scallan, Process planning, Design/Manufacture Interface, Elsevier science technology Books, Dec-2003
5. <https://nptel.ac.in/courses/112107238/27>

18ME007 INTERNAL COMBUSTION ENGINES

3 0 0 3

Course Objectives

- To learn about the combustion phenomenon in spark ignition engines.
- To learn about the combustion phenomenon in compression ignition engines.
- To study the causes, effects and control of pollutants from an Internal Combustion engine.
- To provide the knowledge of alternate fuels in Internal Combustion engines.
- To impart the knowledge on recent developments in Internal Combustion engines.

Programme Outcomes (POs)

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

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

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

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

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 concepts of combustion phenomena, to evaluate the thermal efficiency and performance characteristics of spark ignition engines.
2. Analyze the stages of combustion, knocking tendencies, and fuel injection characteristics in compression ignition engines for optimizing engine control
3. Formulate suitable emission control strategies such as EGR, SCR, and catalytic converters to meet prescribed environmental standards.
4. Investigate the physicochemical properties, advantages, and limitations of alternative fuels to assess their compatibility and performance in internal combustion engines
5. Illustrate the role of advanced engine technologies such as lean-burn systems, variable valve timing, and HCCI in reducing emissions and enhancing efficiency in internal combustion engines

Articulation Matrix

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

UNIT I**9 Hours****SPARK IGNITION ENGINES**

Spark ignition engine- Mixture requirements, carburetors, fuel injection systems, mono point and multipoint injection, stages of combustion, normal and abnormal combustion, factors affecting knocking-combustion chambers.

UNIT II**10 Hours****COMPRESSION IGNITION ENGINES**

States of combustion in Compression Ignition Engine - combustion knock in compression ignition engines, methods of controlling knock. Direct and indirect injection systems. Combustion chambers. Fuel spray behaviour-spray structure, spray penetration and evaporation. Air motion-turbocharging.

UNIT III**9 Hours****POLLUTANT FORMATION AND CONTROL**

Pollutant -formation of Oxides of Nitrogen in spark ignition and compression ignition engines, hydrocarbon emission - carbon monoxide formation - particulate emissions. Measurement of exhaust emissions- Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyser and flame ionization detector, smoke meters. Methods of controlling emissions- Catalytic converters and particulate traps. Exhaust gas recirculation and Selective catalytic Reduction

UNIT IV**8 Hours****ALTERNATIVE FUELS**

Bio-fuels, alcohol, hydrogen, natural gas and liquefied petroleum gas, bio gas, properties, suitability, engine modifications, merits and demerits as fuels

UNIT V**9 Hours****RECENT TRENDS IN I.C ENGINES**

Lean Burn Engines - stratified charge engines, homogeneous charge compression ignition, plasma Ignition. Variable valve timing, multi-valving, tuned manifolding, camless valve gearing, Variable compression ratio engines

Total: 45 Hours

Reference(s)

1. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Publishing Company Private limited., New Delhi,2015
2. R. B. Mathur and R. P. Sharmal Internal Combustion Engines, Dhanpat Rai Publications, 2010
3. B.P.Pundir, Internal combustion Engines Combustion and Emissions, Narosa Publishing House Private limited, New Delhi, 2017
4. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Publishing Company Private limited., New Delhi, 2013
5. W.W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 2006
6. https://onlinecourses.nptel.ac.in/noc19_me10

18ME008 REFRIGERATION AND AIR-CONDITIONING

3 0 0 3

Course Objectives

- To provide the knowledge on air refrigeration systems
- To study the working of single and multistage vapour compression refrigeration systems
- To learn the operation of vapour absorption and other refrigeration systems
- To impart the knowledge about Psychometrics and its applications
- To learn the parameters involved in design of 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.

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.

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

Course Outcomes (COs)

1. Apply the principles of air refrigeration system operation to solve aircraft refrigeration system performance problems.
2. Analyze the performance of vapor compression refrigeration systems by incorporating subcooling and superheating techniques, and propose a suitable method to achieve enhanced system performance
3. Assess the applicability of non-conventional refrigeration systems with conventional systems to recommend a suitable system for cooling applications.
4. Interpret psychrometric data using charts to solve air conditioning problems in applications such as HVAC design for residential or commercial buildings
5. Select an suitable air conditioning systems by evaluating the parameters involved in system selection and load estimation to ensure optimal performance for indoor environmental conditions.

Articulation Matrix

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

UNIT I**9 Hours****AIR REFRIGERATION SYSTEMS AND REFRIGERANTS**

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. Refrigerants- Desirable properties of refrigerants, Recent substitute for refrigerants.

UNIT II**9 Hours****VAPOR COMPRESSION SYSTEM**

Need for modification of Carnot cycle, Ideal and actual vapour compression cycle, Improvements in simple vapour compression system using flash chamber and flash inter cooler. Compound vapor compression system- Need for compound compression, two stage compression and various arrangements for improvement in coefficient of performance.

UNIT III**9 Hours****OTHER REFRIGERATION SYSTEMS**

Principle, Components, working, limitations and applications of Steam jet refrigeration system, Thermo-electric refrigeration system, Electrolux refrigeration system, Vortex refrigeration system and Cascade refrigeration system.

UNIT IV**9 Hours****APPLIED PSYCHROMETRY**

Principle and properties of psychometric of air, Representation of various psychometric processes on psychometric chart and their analysis, by-pass factor, sensible heat factor, room sensible heat factor, equipment sensible heat factor, grand sensible heat factor, apparatus dew point, ventilation and infiltration, energy efficiency ratio. Use of psychometric charts. Cooling and heating load calculations.

UNIT V**9 Hours****AIR CONDITIONING SYSTEMS**

Comfort Air Conditioning - parameters, requirements, concept of effective temperature, infiltration, internal heat gains, comfort charts. Industrial Air conditioning. Air conditioning systems and their types, selection of system, Components and controls of air distribution, Window air conditioner, split air conditioner, Central air conditioner, load estimation.

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. <https://nptel.ac.in/courses/112105129/>

18ME009 COMPOSITE MATERIALS**3 0 0 3****Course Objectives**

- To provide fundamental knowledge in reinforcement and matrix materials.
- To impart knowledge on polymer matrix composites.
- To impart knowledge on polymer matrix composites. To expose the characteristics and different fabrication techniques of metal matrix composites.
- To impart knowledge on ceramic matrix composites.
- To provide knowledge on advanced 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.

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 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. Interpret the characteristics, processing methods, and applications of metal matrix composites using the rule of mixtures and reinforcement effects.
4. Develop 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	2	-
3	2	3	-	-	-	-	-	-	-	-	-	-	2	2	-
4	2	2	3	2	-	-	-	-	-	-	-	-	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 COMPOSITES	
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.	
UNIT V	9 Hours
ADVANCES IN COMPOSITES	
Carbon fiber composites - properties, chemical vapor deposition - oxidative etching, liquid phase oxidation carbon/carbon composites - properties and applications of C/C Composites, future scope of c-c composites, multi-filament superconducting composites.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. P.K. Mallick, Fiber Reinforced Composites Materials, Manufacturing and Design, MarceDekker Inc, 2003.2. K. Autar Kaw, Mechanics of Composite Materials, CRC Press, 2006.3. B.D. Agarwal and L.J. Broutman, Analysis and Performance of Fiber Composites, JohWiley and Sons, New York, 2000.4. Ronald Gibson, Principles of Composite Material Mechanics, Tata McGraw Hill, 2004.5. K.K. Chawla, Composite materials, Springer Verlag, 2007.	

**18ME010 STATISTICAL QUALITY CONTROL AND
RELIABILITY ENGINEERING****3 0 0 3****Course Objectives**

- To familiarize with various statistical process control methods.
- To study the methods and characteristics of sampling.
- To introduce Taguchi method of experimental design.
- To describe the concept of reliability and its models.
- To impart knowledge on design of reliability 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.

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. Interpret the Statistical Process Control (SPC) charts to track the performance of a production process over time and identify trends and variations.
2. Apply the standard sampling plan to select a representative sample from a lot in order to assess its quality and ensure that inspection results accurately reflect the overall quality of the product or process.
3. Demonstrate the Taguchi method using factorial experiments to optimize products and processes, making them less sensitive to variation.
4. Validate the performance of systems and products using reliability functions, and evaluate the reliability of the system and its models.
5. Analyze the reliability design process to identify causes of failure and assess their effects for economic analysis and life-cycle cost evaluation.

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

UNIT I	8 Hours
QUALITY AND STATISTICAL PROCESS CONTROL	
Quality-Definition, Quality Assurance-Variation in process-Factors, Process capability. Control charts variables X, R and X, Attributes P, C and U-Chart tolerance design. Establishing and interpreting control charts-Charts for variables. Quality rating-Short run.	
UNIT II	10 Hours
ACCEPTANCE SAMPLING	
Lot by lot sampling-Types, Probability of acceptance in single, double, multiple sampling plans-Operating Characteristic curves-Producer's risk and consumer's risk-Acceptable Quality Limit, Lot Tolerance Percent Defective, Average Outgoing Quality, Concepts-Standard sampling plans for average outgoing quality and Lot Tolerance Percent Defective, Use of standard sampling plans.	
UNIT III	7 Hours
EXPERIMENTAL DESIGN AND TAGUCHI METHOD	
Fundamentals-Factorial experiments, Random design, Latin square design, Taguchi method-Loss function-Experiments, Signal/Noise ratio and performance measure, Orthogonal array.	
UNIT IV	9 Hours
CONCEPT OF RELIABILITY	
Definition, reliability vs quality, reliability function-Mean Time Between Failures(MTBF),Mean Time To Repair(MTTR), availability, bathtub curve-time dependent failure models-Distributions-Normal, weibull, log normal-Reliability of system and models-serial, parallel and combined configuration -Markov analysis, load sharing systems, standby systems, co-variant models, static models, dynamic models.	
UNIT V	11 Hours
DESIGN FOR RELIABILITY	
Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, System safety-analysis of down-time-Repair time distribution.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Amitava Mitra, Fundamentals of Quality Control and improvement, Wiley,2013.2. Patrick D connor, Practical Reliability Engineering,Wiley,2012.3. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering,Overseas Press,20114. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth-Heinemann,20115. Dhillon, Engineering Maintainability, How to design for reliability and easy maintenance, PH India publications, 2008.6. https://nptel.ac.in/courses/112107238/49	

18ME011 MECHANICAL VIBRATIONS**3 0 0 3****Course Objectives**

- To learn the fundamental concept of vibration of single degree of freedom (DOF) system.
- To expose knowledge on vibration of Two DOF system.
- To expose knowledge on vibration of 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. Analyze the dynamic behavior of Single Degree of Freedom (SDF) systems—including free and forced vibrations, damping effects, and energy methods—to evaluate and predict real-world mechanical vibration responses.
2. Model and analyze two-degree-of-freedom (TDF) mechanical systems to determine natural frequencies, mode shapes, and dynamic responses using principles such as orthogonality, coordinate coupling, and Lagrange's equations.
3. Formulate and solve multi-degree-of-freedom (MDF) vibration problems using exact and approximate methods to determine natural frequencies, mode shapes, and system behavior.
4. Analyze the vibrational behavior of continuous systems such as strings, shafts, and beams using analytical and approximate methods including Rayleigh and Rayleigh-Ritz techniques.
5. Apply vibration measurement techniques and control methods to monitor, analyze, and reduce vibrations in mechanical systems using transducers, damping, isolation, and absorbers.

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	-	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
5	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 - Responses of undamped forced vibration and damped forced vibration - Response of damped system under base excitation - Rotating unbalance. Introduction to Energy methods.	
UNIT II	9 Hours
TWO DEGREE FREEDOM SYSTEM (TDF)	
General equation of motion - Principal mode of vibration - Coordinate coupling - Orthogonality principle - Rectilinear and torsional systems - Natural frequencies of undamped free vibration systems - Equations of motion for forced vibrations and damped free vibration - Dynamic vibration absorber - Lagrange's equation.	
UNIT III	9 Hours
MULTI-DEGREE FREEDOM SYSTEM (MDF)	
Exact Analysis of MDF Modelling of MDF systems by equations of motion from Newton's law - Influence coefficients - Stiffness coefficients and Generalised coordinate - Eigenvalue problems and solution to eigenvalue problems. Approximate methods in MDF Determination of natural frequencies by 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 - Longitudinal vibration of shaft - Torsional vibration of shaft - Lateral vibration of beam - Rayleigh's Method and Rayleigh-Ritz method	
UNIT V	9 Hours
VIBRATION MEASUREMENT AND CONTROL	
Transducers - Vibration Pickups - Frequency Measuring Instruments - Vibration exciters. Control of vibration- Control of Natural frequencies - Introduction to damping. Vibration Isolation - Vibration Absorbers.	
	Total: 45 Hours
Reference(s)	
1. Rao, S. S. Mechanical Vibrations, Pearson Education, 2011. 2. Thomson W.T. Theory of Vibration with Applications, CBS Publishers and Distributors, New Delhi, 2006. 3. Mallik, A, K, Principles of Vibration Control, Affiliated East-West Press Pvt. Ltd, 2004. 4. Rao V. Dukkipati J. Srinivas. Text book of Mechanical Vibrations, PHI Learning Pvt Ltd, New Delhi, 2016. 5. Graham Kelly G and Shashidar K. Kudari, Mechanical Vibrations, Tata McGraw-Hill Publishing Company Ltd New Delhi, 2007. 6. http://nptel.ac.in/courses/112103111/	

18ME012 SUPPLY CHAIN MANAGEMENT**3 0 0 3****Course Objectives**

- To understand the individual processes of supply chain management and their interrelationships 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.

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. Apply the fundamental concepts, functions, and elements of supply chain and logistics in manufacturing and retail environments.
2. Implement the strategies and IT tools to effectively manage retail distribution, replenishment, transport cycles, and green transport solutions.
3. Analyze the order management and reverse logistics processes, including perfect order metrics, return policies, and reverse logistics network design.
4. Apply the contemporary retail logistics challenges such as shrinkage, green logistics, and outsourcing to 3PL/4PL providers with reference to Indian retail practices.
5. Implement the role of IT in warehouse management processes, cross-docking operations to enhance warehouse performance and value-added services.

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

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

Concepts of Supply Chain and Logistics - Elements of Supply Chain - Elements of Logistics - Manufacturing Supply Chain - Functions of Manufacturing Supply Chain - Retail Supply Chain - Functions of Retail Supply Chain -Scope of Retail Logistics - Retail Supply Chain Management as a subset of Retail Management -Retail supply chain elements.

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 logistics -Retail Transport -Transportation Cycle of a retailer - Using IT in Transport Management -Green Transport	
UNIT III	9 Hours
ORDER MANAGEMENT AND REVERSE LOGISTICS	
Order Management -Order Management Process - Concept of perfect order- Perfect order measures -Multi channel logistics -Retail Return and reverse logistics -Return Policy - Return Process -Reverse Logistics- Reverse logistics 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 - Approach for 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 - Retail Logistic Service Provider - An Indian perspective	
UNIT V	9 Hours
WAREHOUSE MANAGEMENT	
Cross Docking -Advantages of cross docking - How cross docking works -Cross Docking Functions - Necessary ingredients for Cross Docking - How cross docking saves time -Warehouse Process Maturity Model -IT in warehouse Management - Measures of warehouse Management - Retail Warehousing -Basic Functions of retail warehouse-Value added services of a Retail Warehouse	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Rajesh Ray, Supply Chain Management for Retailing, Tata McGraw Hill Education Private Ltd2. Janat Shah, Supply Chain Management, Text and Cases, Pearson Education, 20093. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 2007.4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5th Edition, 2007.5. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.6. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 2005.	

18ME013 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.

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

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

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

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

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

Course Outcomes (COs)

1. Illustrate the evolution of manufacturing systems and illustrate how CAD/CAM integration, automation protocols, and external communication systems enhance modern manufacturing.
2. Compare the coding systems like DCLASS, MICLASS, and OPITZ to infer their role in Group Technology and facility design for cellular manufacturing.
3. Apply the computer-aided process plans using variant and generative approaches, integrating them with shop floor control systems and automated data collection technologies.
4. Analyze the flexible manufacturing systems (FMS) and their layout, components, and computer control to validate their efficiency in real-time shop floor scenarios.
5. Develop database architectures and communication protocols like MAP/TOP to simulate seamless data flow and integration in an open CIM environment.

Articulation Matrix

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

18ME014 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.

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

Course Outcomes (COs)

1. Apply the fundamental concepts of process planning and cost estimation in manufacturing environments.
2. Analyze the cost estimation procedures to identify the components of direct, indirect, and overhead costs.
3. Compute the overall production cost for forging, welding, and casting operations through systematic estimation techniques.
4. Estimate the machining time for lathe, drilling, boring, shaping, milling, and grinding operations using standard formulas.
5. Design an optimal process plan by selecting suitable machines, materials, and cost-effective manufacturing 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	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I 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.	7 Hours
UNIT II 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.	10 Hours
UNIT III 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.	6 Hours
UNIT IV 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.	10 Hours
UNIT V 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.	12 Hours
	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 6. B.L. Juneja, Fundamentals of metal forming processes, New Age International private Limited, New Delhi, 2012	

18ME015 INDUSTRIAL 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.

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

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

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

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

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. Analyze the evolution and application of safety management systems using job safety analysis, accident causation models, and performance monitoring techniques.
2. Apply statutory provisions from the Factories Act, Tamil Nadu Factories Rules, and environmental regulations to ensure legal compliance in industrial settings.
3. Evaluate safety practices in engineering industries involving machinery, gas handling, metal forming, and protective equipment to identify risks and recommend improvements.
4. Assess safety systems in chemical industries through process safety analysis, HAZOP studies, plant maintenance strategies, and emergency planning.
5. Design comprehensive safety reports and plans for construction projects by incorporating regulatory guidelines, hazard identification, and safe equipment usage.

Articulation Matrix

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

UNIT I**8 Hours****SAFETY MANAGEMENT**

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II**10 Hours****SAFETY AND LAW**

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, Building and other construction works act 1996, Electricity Rules.

UNIT III**10 Hours****SAFETY IN ENGINEERING INDUSTRIES**

Safety in machine shop, Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV**9 Hours****SAFETY IN CHEMICAL INDUSTRIES**

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance-HAZOP study.

UNIT V**8 Hours****SAFETY IN CONSTRUCTION INDUSTRY**

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey, 1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act, 1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

18ME016 ADDITIVE MANUFACTURING**3 0 0 3****Course Objectives**

- To provide knowledge on generic steps of Additive Manufacturing (AM) technique.
- To learn the concept and applications of liquid and solid based AM processes
- To impart knowledge on powder based AM processes.
- To introduce the concept of open source 3D printers and rapid tooling
- To expose the emerging trends and applications of Additive Manufacturing technology

Programme Outcomes (POs)

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

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

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

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 steps of the additive manufacturing process, use suitable file formats, and compare it with traditional manufacturing methods
2. Assess the principles, construction, and applications of liquid polymer and solid-based AM systems like SLA, DLP, FDM, and LOM.
3. Analyze powder-based additive manufacturing processes such as SLS, DMD, EBM, and LENS with respect to process parameters and material suitability.
4. Investigate the structure and operation of open-source 3D printers and evaluate rapid tooling methods for industrial applications.
5. Develop solutions for medical, automotive, aerospace, and other sectors using reverse engineering techniques and AM technologies

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	-	2	-	-
4	2	2	2	-	-	-	-	-	-	-	2	-	2	-	-
5	2	2	2	-	-	-	-	-	-	-	2	-	2	-	-

UNIT I	7 Hours
INTRODUCTION	
Needs - Impact of AM and Rapid 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 - RP Benefits - Classification of RP systems	
UNIT II	7 Hours
LIQUID POLYMER AND SOLID BASED SYSTEMS	
Stereolithography Apparatus (SLA), Digital Light Projection (DLP), Continuous Liquid Interface Production (CLIP), Photo polymerization process, Fused Deposition Modeling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Materials and Applications.	
UNIT III	10 Hours
POWDER BASED SYSTEMS	
Selective Laser Sintering (SLS), Color Jet Printing, Direct Metal Deposition (DMD), Ballistic Particle Manufacturing (BPM), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS)- Working Principle, Construction, Process Variables, Materials and Applications	
UNIT IV	11 Hours
OPEN SOURCE PRINTER AND RAPID TOOLING	
Concept of open source 3D printer - Structural details, Control mechanism - Materials and Applications. Introduction to rapid tooling (RT) - Direct and Indirect tooling - Silicone rubber moulding, Epoxy tooling, Spray Metal Coating, 3D printing direct, Electro Optical Sintering (EOS) - Working Principle, Materials and Applications	
UNIT V	10 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)	
<ol style="list-style-type: none">1. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.2. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.3. 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/978-1-4939-2112-64. L. W. Liou, F. W. Liou, Rapid Prototyping and Engineering applications: A toolbox for prototype development, CRC Press, 2013.5. Yang, L., Hsu, K., Baughman, B., Godfrey, D., Medina, F., Menon, M., Wiener, S., Additive Manufacturing of Metals: The Technology, Materials, Design and Production, Springer, 2017 https://doi.org/10.1007/978-3-319-55128-96. www.all3dp.com, www.3dprintingindustry.com, www.reprap.org, www.thingiverse.com	

18ME017 NON - DESTRUCTIVE TESTING**3 0 0 3****Course Objectives**

- To learn different surface inspection techniques.
- To provide knowledge on sub surface testing methods.
- To impart knowledge on ultrasonic testing method.
- To provide knowledge on radiography testing method.
- To study various special non-destructive testing methods.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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 the principles, advantages, and limitations of surface NDT methods like Visual Inspection and Liquid Penetrant Testing.
2. Analyze the subsurface techniques such as Magnetic Particle and Eddy Current Testing for detecting material defects.
3. Illustrate the Ultrasonic testing methods, including Pulse-Echo and Phased Array, for flaw detection and weld inspection.
4. Assess the quality of Radiographic Testing techniques, including exposure parameters, film handling, and safety aspects.
5. Infer the applications of advanced NDT methods such as Acoustic Emission, Thermography, Leak Testing, and Laser Stereography for industrial use.

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	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-

UNIT I	9 Hours
SURFACE TECHNIQUES	
Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, Visual or Optical Testing - Direct and remote visual inspection and Aides. Liquid Penetrant Testing (LPT) Principles - Types and properties of liquid penetrants and developers - Preparation of test materials - Advantages and limitations - Application of penetrants to parts - fluorescent penetrant test	
UNIT II	9 Hours
SUB SURFACE TECHNIQUES TESTING	
Magnetic Particle Testing (MPT) - Principles, applications, magnetization methods, magnetic particles - Dry particle technique and Wet fluorescent particle technique - Advantages and Limitations. Eddy Current Inspection - Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations	
UNIT III	9 Hours
ULTRASONIC TESTING	
Ultrasonic Testing (UT) - Principle, Types and characteristics of Ultrasonic waves - Attenuation, Couplants, Probes - Inspection methods - Pulse echo, Transmission and Phased Array techniques (PAUT), Types of scanning and displays - Angle beam inspection of welds - Calibration of ASTM Test blocks, International Institute of Welding IIW) reference blocks - Applications	
UNIT IV	9 Hours
RADIOGRAPHY TESTING	
Radiographic testing (RT) -Principle, Sources of X-rays and Gamma rays and their characteristics - Absorption, scattering, Filters and screens, imaging modalities - Film radiography and Digital Radiography - Problems in shadow formation, Exposure factors, film handling and storage- Inverse square law, Exposure charts, and Radiographic equivalence, Penetrometers - Safety in radiography- Applications	
UNIT V	9 Hours
SPECIAL NDT TECHNIQUES	
Acoustic Emission Testing (AET) Principle - Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) - Principle, Techniques and applications. Leak Testing - Principle, Testing Procedure and applications. LASER Stereography- Typical applications- Requirements - advantages and disadvantages.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Charles J. Hellier, "Handbook Of Nondestructive Evaluation", McGraw-Hill Education; 2 edition 2012.2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, 2009.3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001.4. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., 1988.5. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995.6. https://onlinecourses.nptel.ac.in/noc19_mm07/course	

18ME018 RENEWABLE ENERGY SOURCES**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.

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 thermal applications for power generation.
2. Analyze the performance of solar PV systems by applying the photovoltaic principles.
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 and geothermal energy systems for effective energy harnessing.
5. Develop hydrogen-based energy systems and fuel cell technologies for 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	3	-	-	-	2	2	-	-	-	-	-	-	-	2
3	3	-	-	-	-	2	2	-	-	-	-	-	-	-	2
4	2	2	2	2	-	2	2	-	-	-	-	-	-	-	2
5	3	2	2	-	-	2	2	-	-	-	-	-	-	-	2

UNIT I	9 Hours
SOLAR THERMAL SYSTEMS	
Solar radiation spectrum, Radiation measurement, Estimation of average solar radiation, Introduction to solar collectors (liquid flat- Plate collector - Air heater and concentrating collector) Solar distillation, Solar drying, Solar thermal system for power generation.	
UNIT II	9 Hours
SOLAR PHOTOVOLTAIC SYSTEMS	
Operating principle, Photovoltaic cell concepts, Cell, module, array, Voltage current characteristics of a solar cell, Series and parallel connections, Maximum power point tracking, Applications - Battery charging, Pumping, Lighting	
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 - Merits and demerits of wind energy systems. Biofuels classification, Biomass gasification- Technologies for utilisation of biomass, Biogas - Production, factors affecting biogas production, biogas plants.	
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 -Methodology, Applications. Geothermal energy - classification of geothermal resources, schematic of geothermal power plants, operational and environmental problems	
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, Alkaline Fuel cells (AFC), Phosphoric Acid Fuel cells (PAFC), Polymer Electrolyte Membrane Fuel cells (PEMFC), Specific characteristics, advantages and applications.	
FOR FURTHER READING	
Design of Solar Thermal Systems, PV Panel Sizing, Economic Analysis of Wind Energy, Need for Hybrid Systems, Fuel cell Hybrids	
	Total: 45 Hours
Reference(s)	
1. Rai. G.D., Non Conventional Energy Sources, Khanna Publishers, New Delhi, 2011.	
2. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd., UK, 2006	
3. Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19- 926178-4).	
4. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition). Gaiam.	
5. Sukhatme, Suhas P., and J. K. Nayak. Solar energy. McGraw-Hill Education, 2017.	
6. https://onlinecourses.nptel.ac.in/noc19_ge11/course	

18ME019 CRYOGENIC ENGINEERING**3 0 0 3****Course Objectives**

- To learn about the cryogenic material properties and applications of cryogenics.
- To impart knowledge on Liquefaction cycles.
- To provide knowledge about gas separation and purification.
- To study the working of various cryo coolers.
- To learn about the construction of Dewar vessels and cryogenic instrumentation.

Programme Outcomes (POs)

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

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

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

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

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

Course Outcomes (COs)

1. Apply the cryogenic principles to analyse material and fluid properties at cryogenic temperatures and their applications across various fields.
2. Assess the performance, figure of merit, liquefaction yield, and efficiency of various gas liquefaction methods.
3. Apply the principles of gas separation and purification to compare ideal separation methods and rectification processes using theoretical plate calculations and Murphree efficiency.
4. Analyze the working principles of Stirling, Gifford-McMahon, and Pulse Tube cryocoolers to compare their operational characteristics and practical applications.
5. Investigate the design and function of cryogenic Dewar vessels, transfer lines, insulation systems, and instrumentation techniques used for temperature, flow, and level measurement.

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

UNIT I**7 Hours****INTRODUCTION TO CRYOGENICS**

Insight on cryogenics - properties of cryogenic fluids - material properties at cryogenic temperatures - Applications of cryogenics in space programs, superconductivity, cryo metallurgy, biological and medical applications

UNIT II	9 Hours
LIQUEFACTION CYCLES	
Basics of Refrigeration - Methods of production of low temperatures - Joule Thompson expansion - inversion curve. Gas Liquefaction cycles - Carnot liquefaction cycle, Simple Linde Hampson cycle, Precooled Linde-Hampson cycle, Simple Claude cycle, Dual pressure Claude cycle - Figure of merit and yield of liquefaction cycle.	
UNIT III	11 Hours
SEPARATION AND PURIFICATION SYSTEMS	
Basics of Gas separation - Ideal separation of gases, characteristics of mixtures and the governing laws - T-C and H-C diagrams. Principle of Rectification - Rectification column - Theoretical plate calculations using McCabe-Thiele method, murphree efficiency. Gas purification.	
UNIT IV	9 Hours
CRYOGENIC REFRIGERATORS	
Cryocoolers - Fundamentals, classification, comparison and applications. Working of Stirling, Gifford-McMahon and Pulse tube cryocoolers	
UNIT V	9 Hours
STORAGE AND INSTRUMENTATION	
Cryogenic Dewar vessels construction and design, cryogenic transfer Lines. Cryogenic insulation - vacuum, powder, multi-layer, micro-sphere and foam-fibrous insulation - concept of vapour coated shields. Cryogenic instrumentation - temperature, flow and level measurements.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Mamata Mukhopadhyay, Fundamental of Cryogenic Engineering, PHI learning Private Limited, New Delhi, 2014.2. Thomas M. Flynn, Cryogenics Engineering, Marcel Dekker, New York, 2005.3. G.G. Haselden, Cryogenics Fundamentals, Academic Press Inc., London, 1999.4. K.D. Timmerhaus and T.M. Flynn, Cryogenics Process Engineering, Plenum Press, New York, 1989.5. Randall F. Barron, Cryogenic System, 2nd edition, Oxford University Press, New York, 1985.6. https://nptel.ac.in/downloads/112101004/	

18ME020 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.

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 fundamental tribological principles to assess material suitability for engineering applications.
2. Investigate the deformation and stress behavior in engineering surfaces by applying surface characterization and contact mechanics.
3. Analyze friction mechanisms and evaluate the effects of frictional heating and instability in mechanical systems.
4. Interpret wear models and measurement techniques to predict and control wear in different materials and applications.
5. Infer the Reynolds and Ertel-Grubin equations for tribological applications to demonstrate the performance characteristics of lubricants and lubrication regimes.

Articulation Matrix

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

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
FRICITION	
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/	

18ME021 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.

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

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

Course Outcomes (COs)

1. Apply principles of boiler operation and thermodynamic cycles to evaluate the performance of high-pressure, supercritical, and fluidized bed boilers.
2. Design a coal handling and combustion system for a steam power plant, integrating mechanical stokers, pulverizers, and electrostatic precipitators to optimize performance and meet environmental standards.
3. Analyze nuclear and hydel power plant layouts, types of reactors, and energy generation principles to assess their suitability for sustainable power production.
4. Illustrate the principles of thermodynamics and fuel utilization to identify the efficient operation of diesel and gas turbine power systems under different operating conditions
5. Demonstrate a hybrid power system by integrating multiple renewable sources such as wind, solar, and OTEC technologies to meet variable energy demands efficiently.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	-	-	-	-	1	-	-	-	-	1	-	-	-	2
2	2	2	2	-	-	-	1	1	-	-	-	1	-	-	2
3	2	3	-	-	-	-	1	-	-	-	-	1	-	-	2
4	3	-	-	-	-	-	1	-	-	-	-	1	-	-	2
5	2	2	2	-	-	-	1	1	-	-	-	1	-	-	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, 2013. 2. K.K.Ramalingam, Power Plant Engineering, Scitech Publications (India) Private Limited, 2002. 3. P. K. Nag, Power plant Engineering, Tata McGraw Hill Company Private Limited, New Delhi, 2014. 4. G. R. Nagpal, Power Plant Engineering, Khanna Publishers, New Delhi, 2002. 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.	

18ME022 OPTIMIZATION TECHNIQUES

3 0 0 3

Course Objectives

- To impart knowledge on concept of optimization and problem formation.
- To provide knowledge on optimization methods for single variable unconstrained problems
- To educate about multi-objective unconstrained optimization problems solving algorithms.
- To impart concepts of constrained non-linear optimization problems
- To provide input on non-traditional optimization techniques to solve engineering problems

Programme Outcomes (POs)

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

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

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

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

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

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

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

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 fundamental concepts of design optimization and interpret problem formulation procedures for engineering systems
2. Apply appropriate mathematical techniques to compute the optimal solution for single-variable unconstrained optimization problems
3. Analyze the solution strategies for multivariable unconstrained optimization problems using appropriate analytical or numerical methods.
4. Design systematic approaches to obtain solutions for constrained non-linear optimization problems relevant to engineering applications
5. Apply non-traditional optimization techniques, such as genetic algorithms and simulated annealing, to address complex engineering problems.

Articulation Matrix

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

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

Introduction to design optimization-Historical development, the design process, Conventional Vs Optimum design process - Statement of an optimization problem- Optimum design problem formulation - process steps, Problem formulation for engineering applications - Two-bar bracket, Design of coil springs- Classifications of optimization problems.

UNIT II **9 Hours****SINGLE VARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS**

Optimality criteria - Unimodal function - Eliminating methods - Exhaustive search, Dichotomous search, Interval halving method, Fibonacci search method, Golden section search method. Point estimation method (Powell's algorithm) - Gradient-based methods - Newton-Raphson method (Taylor's series expansion), Bisection method, Secant method, Cubic search method.

UNIT III **9 Hours****MULTI VARIABLE NONLINEAR UNCONSTRAINED OPTIMIZATION ALGORITHMS**

Optimality criteria - Unidirectional search - Direct search methods - Evolutionary optimization method, Random search methods, Simplex search method, Hooke-Jeeves pattern search method, Indirect search(gradients) methods- Cauchy's (steepest descent) method, Newton's method, Conjugate gradient method.

UNIT IV **9 Hours****CONSTRAINED NONLINEAR OPTIMIZATION ALGORITHMS AND SPECIALIZED PROGRAMMING**

Introduction, Characteristics - Indirect search methods - Transformation methods, Penalty function method, Method of multipliers - Sensitivity analysis - Kuhn-Tucker conditions, Theorems. Test problems on three-bar truss, welded beam design. Direct search minimization methods- Variable elimination method, Complex search method and Random search methods - Feasible direction method. Integer programming - Penalty function method, Branch and Bound method.

UNIT V **9 Hours****NONTRADITIONAL OPTIMIZATION TECHNIQUES**

Genetic Algorithms (GA)- principle, difference and similarities between GA and traditional methods, constrained optimization, GA operators, Real-coded and Advanced GAs - Simulated Annealing - Neural Network based Optimization.

Total: 45 Hours

Reference(s)

1. Singiresu S.Rao, Engineering Optimization: Theory and Practice, Fourth Edition, Wiley IndiaPvt Ltd, Delhi,2009
2. Kalyanmoy Deb, Optimization for Engineering Design- Algorithms and Examples, Second Edition, PHI Learning Pvt. Ltd., New Delhi,2012.
3. Jasbir Singh Arora, Introduction to Optimum design, Third Edition, Elsevier India Pvt.LtdNew Delhi, 2011.
4. R.Saravanan, Manufacturing optimization through intelligent techniques, First Edition, Taylor& Francis Publications, CRC Press, New Delhi, 2006.
5. Optimization Techniques and Applications with Examples, Xin-She Yang, Wiley India Pvt Ltd, Delhi,2018.

18ME023 DESIGN FOR MANUFACTURE 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.

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

UNIT I **10 Hours****GEOMETRIC DIMENSIONING AND TOLERANCING**

Tolerance Chains and identification of functionally important dimensions. International Tolerance Grades, Surface finish, Attainable tolerance grades and different machining processes. Geometric Dimensioning and Tolerancing - Location, Form, profile, orientation, run out and Feature tolerance. Tolerance Limits for Assembly - Cumulative effect of Tolerances

UNIT II **10 Hours****DESIGN CONSIDERATIONS FOR CASTINGS, WELDING AND FORMING**

Casting - Pattern, Mould, Casting hole - cast, Cored and Machined holes, Parting line - Redesign of castings based on parting line considerations, Minimizing core requirements. Welding - Stresses in welding - Measures to combat contraction stresses - Welding sequence - Joints in Welding - Weldability of steel - Design of welded structures. Form design aspects for Forging and sheet metal components

UNIT III **8 Hours****DESIGN FOR MANUFACTURE - MACHINING CONSIDERATIONS**

Design for Manufacture Guidelines - Design features to facilitate machining - Drills - Milling cutters -Keyways - Doweling procedures, Counter sunk screws - Reduction of machined area Simplification by separation - Simplification by amalgamation. Design for Manufacture: Machinability, Economy, Clampability, Accessibility, Assembly. Redesign for Manufacture -Examples.

UNIT IV **8 Hours****DESIGN FOR ASSEMBLY**

Design for Assembly(DFA) Guidelines - Minimizing number of Parts - Insertion and Fastening - Design Guidelines for Part Handling - Effect of Part Symmetry, Part Thickness, Part Size, Weight on Handling Time - Types of Manual Assembly Methods - Effect of Assembly layout on Part Acquisition Time - Assembly Efficiency - DFA index.

UNIT V **9 Hours****DESIGN FOR ENVIRONMENT**

Environmental objectives - Global issues, Regional and local issues - Basic Design for Environment (DFE) methods - Design guide lines - Lifecycle assessment - AT&T's (American Telephone and Telegraph Company) environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly, Recyclability, Remanufacture, Energy efficiency - Design to regulations and standards.

FOR FURTHER READING

Case studies - Design components for casting, welding, forging and machining processes. Design components for minimizing environmental impact.

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.

18ME024 INDUSTRIAL ENGINEERING**3 0 0 3****Course Objectives**

- To impart the knowledge on production system 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 equipments.
- To learn about system analysis and different types of maintenance.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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. 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	3	-	-	-	-	-	-	-	-	-	-	1	-	2	-
2	2	3	-	-	-	-	-	-	-	-	-	1	-	2	-
3	2	2	-	2	-	-	-	-	-	-	-	1	-	2	-
4	2	2	2	-	-	-	-	-	-	-	-	1	-	2	-
5	2	2	3	-	-	-	-	-	-	-	-	1	-	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. Production system Analysis, Input-output model, Productivity, Factors affecting productivity. Plant layout, Criteria for a good layout, Types of layout - Process layout, Product layout, Combination layout, and Fixed position layout. Material flow pattern, Workstation design.	
UNIT II	9 Hours
PROCESS PLANNING AND PRODUCTION CONTROL	
Introduction to Process planning- Definition, Procedure, Process selection, Machine capacity, Process sheet, Process analysis. Group technology - Definition, Classification and coding system, Formation of component family. Production planning - Introduction, Functions, Loading, Scheduling. Production control - Dispatching, Routing. Progress control - Bar, Curve, Gantt chart, Route and Schedule chart.	
UNIT III	9 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. The flow diagram, String diagram, Multiple activity chart, Principles of motion economy, Therbligs, SIMO chart, Stopwatch procedure. Ergonomics- applications of ergonomic principles in the shop floor- work benches-seating arrangement.	
UNIT IV	9 Hours
INVENTORY MANAGEMENT AND MATERIAL HANDLING	
Inventory - Definition, Objectives, Classification, Functions, Economic order quantity, Economic batch quantity, Inventory models, ABC analysis. Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, Just in Time manufacturing system, KANBAN technique, Material handling - Definition, Functions, Principles, Equipment selection, and Equipment types.	
UNIT V	9 Hours
SYSTEM ANALYSIS AND MAINTENANCE	
System concept, System analysis, System engineering, Techniques, Applications. Value analysis/Engineering - Definition, Types of values, Aim, Technique, Procedure, Advantages, Applications, Value engineering versus Value control. Plant maintenance department - Objectives, Importance, Duties, Functions, and Responsibilities. Types of maintenance - Breakdown, Scheduled, Preventive and Predictive. Plant maintenance schedule - Introduction, Procedure.	
FOR FURTHER READING	
Industrial Psychology, Industrial relations, Industrial legislation, Applied anthropometry, Biostatic mechanics, Estimation and costing concepts.	

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010.
2. Panneerselvam R., Production and operations management, Heritage Publishers, 2006.
3. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006.
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009.
5. Jan Dul, Bernard Weerdmeester, Ergonomics for Beginners: A Quick Reference Guide, CRC Press, Taylor and Francis group,2008.
6. Lee J. Krajewski, Larry P.Ritaman, Operations Management, Addison Wesley, 2007.

18ME025 INDUSTRIAL MAINTENANCE ENGINEERING

3 0 0 3

Course Objectives

- To Understand the principles, functions and practices adapted in industry for the effective maintenance management.
- To Learn the concept of Preventive and Total Productive Maintenance.
- To Study few methods and instruments for condition monitoring
- To Learn few repair methods for basic machine elements.
- To Learn few repair methods for material handling equipment

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Apply the principles, functions, and practices of maintenance management to improve equipment reliability and system performance.
2. Develop preventive and total productive maintenance strategies to enhance operational productivity.
3. Assess maintenance process performance and recommend corrective actions for continuous improvement.
4. Analyze appropriate repair techniques for basic machine elements to ensure operational efficiency.
5. Select the suitable maintenance and repair methods for material handling equipment based on operational needs.

Articulation Matrix

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

UNIT I **9 Hours**

PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING

Basic Principles of maintenance planning-Objectives and principles of planned maintenance activity-Importance and benefits of sound maintenance systems-Reliability and machine availability-Mean Time Between Failures, Mean Time To Repair and Mean Waiting Time-Factors of availability-Maintenance Organization-Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE POLICIES PREVENTIVE MAINTENANCE

Maintenance categories-Comparative merits of each category -Preventive maintenance, maintenance schedules, repair cycle -Principles and methods of lubrication-Total Productive Maintenance.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance-Cost comparison with and without Condition Monitoring-On-load testing and offload testing-Methods and instruments for Condition Monitoring - temperature sensitive tapes-pistol thermometers-wear-debris analysis

UNIT IV **10 Hours**

REPAIR METHODS FOR BASIC MACHINE ELEMENTS

Failure analysis-Failures and their development-Logical fault location methods-Sequential fault location-Repair methods for beds, slide ways, spindles, gears, lead screws and bearings

UNIT V **8 Hours**

REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT

Repair methods for material handling equipment-Equipment records-Job order systems, Use of computers in maintenance

FOR FURTHER READING

Tribology in Maintenance, friction wear and lubrication, friction & wear mechanisms, prevention of wear, types of lubrication mechanisms, lubrication processes. Lubricants - types, general and special purpose, additives, testing of lubricants, degradation of lubricants, seal & packing

Total: 45 Hours

Reference(s)

1. Srivastava S.K., Industrial Maintenance Management, S. Chand and Company, 2002
2. Venkataraman .K, Maintancence Engineering and Management, Prentice Hall of India Private Limited, 2007
3. Garg M. R., Industrial Maintenance, S. Chand & Co., 1986
4. Mishra R.C., Pathak.K, Maintenance engineering and Management, Prentice Hall of India Private Limited, 2012
5. Higgins R.L, R.Keith Mobley, Darrin Wikoff, Maintenance Engineering Handbook, The McGraw-Hill Companies Inc. 2008.

18ME026 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.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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	
Introduction - Applications and impact of CFD in diverse fields - Navier 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 inviscid Flows - Illustrative and physical examples of Elliptic, Parabolic and Hyperbolic equations - Discretization of partial Differential Equations. Implicit, explicit and Crank Nicolson finite difference methods for viscous flows. Stability, convergence, accuracy.	
UNIT III	9 Hours
FINITE VOLUME METHOD	
Basic rules for FV Discretization. Finite Volume (FV) Discretization of one and two dimensional steady state diffusion type problems - 1-D convection-diffusion type problem - Unsteady flows - implementation of boundary conditions in Finite Volume. Solution of discretized equations. Solution algorithm for Pressure Velocity coupling in steady flows - Pressure-velocity coupling - SIMPLE scheme.	
UNIT IV	9 Hours
FINITE ELEMENT METHOD IN FLUIDS	
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	
Introduction. Algebraic grid generation. Differential Grid Generation. Structured and unstructured grids. Body fitted Coordinate Method.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. J. D. Anderson., Jr. Computational Fluid Dynamics- The Basic with Applications, Tata McGraw Hill Publishing Company Pvt. Ltd., New Delhi, 20042. S. C. Gupta, Applied Computational Fluid Dynamics, Wiley India Pvt. Ltd., New Delhi, 20193. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere, New York, 2004.4. H. K. Versteeg and W. Malalasakera, An Introduction to Computational Fluid Dynamics The Finite Volume Method, Pearson Education Ltd., New Delhi, 2007.5. K. A. Hoffman, Computational Fluid Dynamics for Engineering, Engineering Education System, Austin, Texas 2005.6. Introduction to computational fluid dynamics http://nptel.ac.in/courses/112105045/.	

18ME027 FUELS AND COMBUSTION**3 0 0 3****Course Objectives**

- To introduce the characteristics of fuels
- To provide knowledge on types and properties of solid and liquid fuels
- To impart knowledge on types and properties of gaseous fuels
- To learn about the stoichiometry and kinetics of combustion
- To expose the knowledge on combustion kinetics of fuels

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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 standard fuel testing procedures to assess properties, calorific value, flash point, and viscosity of the fuel for automotive applications.
2. Analyze combustion parameters such as stoichiometric air-fuel ratio, excess air, and thermal efficiency for given fuels using thermodynamic principles
3. Investigate syngas composition and thermal efficiency to select appropriate feedstocks in the gasification process
4. Interpret a layout of basic combustion process by applying combustion principles, selecting appropriate fuels, and considering energy efficiency
5. Develop a combustion control strategy by integrating kinetic mechanisms and flame stability principles to improve thermal efficiency and ensure operational 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	-	-	-	1	-	-	2
2	3	2	-	-	-	-	2	-	-	-	-	1	-	-	2
3	3	2	-	-	-	-	2	-	-	-	-	1	-	-	2
4	3	2	1	-	-	-	2	-	-	-	-	1	-	-	2
5	3	1	2	-	-	-	2	-	-	-	-	1	-	-	2

UNIT I	8 Hours
FUEL CHARACTERISTICS	
Fuels- Types and Characteristics of Fuels-Determination of Properties of Fuels-Fuels Analysis-Proximate and Ultimate Analysis-Moisture Determination- Calorific Value-Gross and Net Calorific Values - Bomb Calorimetry- DuLong's Formula for CV Estimation- Flue gas Analysis- Orsat Apparatus	
UNIT II	10 Hours
SOLID AND LIQUID FUELS	
Solid Fuels: Wood and Wood charcoal - Origin of coal - Composition of coal- Analysis and properties of different grades of coal - preparation and storage of coal - coal washing -Briquetting. Liquid coals: Origin of petroleum fuels - Production - Composition - Petroleum refining. Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, and Cetane Number- Gasification of liquid fuels -Synthetic fuels - Storage and handling of liquid fuels	
UNIT III	9 Hours
GASEOUS FUELS	
Classification - Composition and Properties - Estimation of Calorific Value - Gas Calorimeter. Rich and Lean Gas - Wobbe Index - Natural Gas - Dry and Wet Natural Gas - Stripped NG - Foul and Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas -Town Gas - Coal- Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability	
UNIT IV	9 Hours
COMBUSTION: STOICHIOMETRY	
Stoichiometry - Mass Basis and Volume Basis - Fuel and Flue Gas Compositions - Calculations - Excess Air Calculation from flue gas analysis. Rapid Methods for solid, liquid and gaseous fuels. Thermodynamics - Heat of combustion- Equilibrium constants of combustion reactions - Enthalpy - Temperature diagrams - Flame Temperature - Theoretical -Adiabatic and Actual	
UNIT V	9 Hours
COMBUSTION: KINETICS	
Combustion Processes - Stationary Flame - Surface or Flameless Combustion -Submerged Combustion - Pulsating and Slow Combustion Explosive Combustion. Mechanism of Combustion - Chain reactions - Thermal mechanism - Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation- Ignition Limits - Limits of Inflammability	
FOR FURTHER READING	
Coal Burning Equipments - Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Samir Sarkar, Fuels & Combustion, 3rd Edition, University press, 20092. Bhatt, Vora Stoichiometry, 4th Edition, Tata McGraw Hill, 20043. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corp,2003.4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 19865. Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 19846. https://nptel.ac.in/courses/103105110/	

18ME028 PRODUCTION AND OPERATIONS MANAGEMENT**3 0 0 3****Course Objectives**

- To learn the concept of production and operations management
- To familiarize in identifying the facility location
- To introduce the concept of various forecasting methods
- To emphasise the need of material management and inventory control
- To educate on aggregate production planning

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Apply the principles of integrated production and operations management to improve system, capital, labour, and personnel productivity using industry best practices.
2. Analyze various facility location models and procedures to determine optimal plant and warehouse locations based on cost, revenue, and qualitative factors.
3. Demonstrate the forecasting techniques using qualitative and quantitative models to predict future demand and support decision-making in production systems.
4. Implement materials management strategies and inventory control models to optimize purchasing, storing, and inventory levels in a manufacturing environment.
5. Formulate aggregate production plans by evaluating planning strategies, requirements, and steps to align production with organizational goals and market demand.

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

UNIT I	9 Hours
INTRODUCTION	
Integrated Production Management, System Productivity, Capital Productivity, Labour Productivity, Personnel Productivity, Training; Operations Management and Strategy, Tools for Implementation of Operations, Industry Best Practices.	
UNIT II	9 Hours
FACILITY LOCATION	
Factor influencing plant & warehouse location, impact of location on cost & revenue. Facility location procedure & models; qualitative models, Breakeven analysis, Single facility location model, Multi facility location model, Minimax location, Total & partial covering model	
UNIT III	9 Hours
FORECASTING	
Need for forecasting, the forecasting process, Forecasting methods- qualitative methods, Quantitative models-Time series forecasting models, moving averages, exponential smoothing with trend and seasonal adjustment, multi-item forecasting, Simple and multiple linear regression models, monitoring and controlling forecasts	
UNIT IV	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	
UNIT V	9 Hours
AGGREGATE PRODUCTION PLANNING	
Aggregate planning system, Requirement of Aggregate Plan, Steps in Developing an Aggregate Plan, Advantages of Aggregate Plan, Aggregate Planning Strategies, Planning Options. Selecting the Method in Aggregate Planning, Aggregate Planning in Services.	
	Total: 45 Hours
Text Book(s)	
1. Panneerselvam,R. Production and Operations Management, PHI, 2018. 2. R.B. Khanna, Production and operations management, PHI, 2015	
Reference(s)	
1. Jay Heizer and Barry Render, Operations Management, Pearson College Division, 2013 2. N. Chary, Production and operations management, Tata McGraw- Hill Publishing Company Ltd, New Delhi. 2008. 3. https://onlinecourses.nptel.ac.in/noc18_me26/preview	

18ME029 GREEN MANUFACTURING**3 0 0 3****Course Objectives**

- Learn and understand the basic concept of green manufacturing and its significance
- Learn and understand the societal implications of green manufacturing
- Apply the concept of Green manufacturing in real time environment
- Learn the analytical methods and Techniques of green manufacturing
- Apply and analyze green manufacturing in design, implementation and its economics in industrial environment

Programme Outcomes (POs)

- PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 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.

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 drivers, barriers, and environmental impacts associated with adopting green manufacturing strategies under regulatory, economic, and competitive contexts.
2. Apply the role of financial, ecological, and societal metrics to assess sustainability through green supply chain strategies and material-energy flow analysis.
3. Interpret the principles and technology wedges of green manufacturing to evaluate life cycle benefits and environmental impact of production systems.
4. Validate green energy technologies such as solar, wind, and fuel cells to determine cost-benefit and emission mitigation potential in manufacturing applications.
5. Demonstrate process monitoring and energy profiling techniques in green manufacturing to optimize energy usage and reduce resource waste.

Articulation Matrix

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

UNIT I	8 Hours
INTRODUCTION	
Why GM-Definition-Motivation and Barrier to GM-regulatory pressure-economic incentive-competitive advantage-Pillars of GM-environmental impact-carbon emission- waste generation-energy consumption-strategies for GM	
UNIT II	9 Hours
METRICS FOR GREEN MANUFACTURING(GM)	
Overview of metrics-Financial metrics- Metrics for ecology- metrics for society-Multiple metrics-Material and energy flow analysis-Green supply chain-definition-motivation-techniques of green supply chain-future of green supply chain	
UNIT III	10 Hours
PRINCIPLES OF GM	
Technology wedges for GM-Five principles of GM-Mapping of principles- Closed loop production system-Life cycle of production system-benefits- machine tools and energy consumption	
UNIT IV	8 Hours
GM THROUGH GREEN ENERGY SUPPLY	
Green energy technologies-solar photovoltaics-wind energy-fuel cell- applications-technology performance-cost benefit of emission mitigation-examples of green house gas emission mitigation.	
UNIT V	10 Hours
TECHNOLOGY FOR GREEN MANUFACTURING	
Process monitoring system-electrical flow-fluid flow-cutting fluid-compressed air-water-case study-energy consumption and spindle rpm profile	
FURTHER READING	
Future of green manufacturing, Case Study : semi conductor manufacturing, Green supply chain	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. David Dornfeld, Chris Yuan, Nancy Diaz, Teresa Zhang, and Athulan Vijayaraghavan, Introduction to Green manufacturing, First Edition, Springer, 20132. DAVID R. HILLIS, J. BARRY DUVALL, Improving Profitability Through Green Manufacturing, First Edition, JOHN WILEY & SONS, INC, 20123. Jiri Klemes, Ferenc Friedler, Igor Bulatov, Petar Varbanov, Sustainability in the Process Industry, First Edition, Mc Graw Hill, 20114. M. Thirugnanasambandam, CO2 Emission Mitigation Through Energy Conservation- A practical Guide, First Edition, Shanlax Publishers, India, 2018	

18ME030 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.

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

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

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

Course Outcomes (COs)

1. Interpret the concepts of idea, strategic planning, and product design in new product development, and analyze the factors involved in commercialization and collaboration
2. Implement the engineering principles and product design tools such as QFD, CAD, robust design, DFX, DFM, DFA, and ergonomics to enhance product functionality, manufacturability, and user experience.
3. Assess the principles of Product Data Management and the Engineering Change Management (ECM) process, including the roles and steps involved in implementing engineering changes in industry.
4. Apply design guidelines for manual assembly and various manufacturing processes, and utilize sustainable product design strategies for product development in the automobile industry.
5. Integrate reverse engineering tools such as CMM, laser scanners, CT, and MRI for point data acquisition in rapid prototyping across medical, manufacturing, automotive, aerospace, electronics, and retail industries.

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

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 -Commercialisation - 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)	
<ol style="list-style-type: none">1. T. Karl, Ulrich and D. Steven, and Eppinger, Product Design and Development, McGraw Hill 20092. Harry Peck, Designing for Manufacture, Pitman Publishing, London, 19733. Robert Matousek, Engineering Design - A Systematic Approach, Blackie and Son Limited, London, 19744. M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall, New Jersey, 20075. Kevin otto, Kristin wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson education, 20036. https://nptel.ac.in/courses/112107217/	

18ME031 NANOMATERIALS AND NANOTECHNOLOGY**3 0 0 3****Course Objectives**

- To provide knowledge on basic concepts and size dependent properties of nano materials
- To familiarize nano materials based on property and structure
- To impart knowledge on different synthesis techniques of nano materials
- To perform different characterization techniques.
- To apply the concepts of nano materials in Nano 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.

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

Course Outcomes (COs)

1. Illustrate the fundamentals of nanoscience and the influence of nanoscale dimensions on material properties
2. Compare different nano forms of carbon and metal oxides in terms of structure, functionalization, and applications
3. Formulate suitable synthesis methods for nanomaterials using top-down and bottom-up approaches.
4. Investigate nanomaterial characterization techniques and validate their structural and thermal behavior.
5. Design nano-enabled devices for applications in electronics, biotechnology, and energy, and illustrate their engineering relevance.

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

UNIT I	9 Hours
INTRODUCTION	
Nano scale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra thin films multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.	
UNIT II	9 Hours
NANO MATERIALS	
Nano forms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT) - Nano metal oxides- ZnO, TiO ₂ , MgO, ZrO ₂ , NiO, nano alumina, CaO, AgTiO ₂ , Ferrites, Nano clays-functionalization and applications-Quantum wires.	
UNIT III	9 Hours
SYNTHESIS OF NANO MATERIALS	
Top-down processes - mechanical milling, nanolithography and types based on radiations - Bottom-up process - chemical vapour deposition, plasma enhanced CVD, colloidal and sol-gel methods - template based growth of nano materials -ordering of nano systems, self-assembly - DC sputtering and RF sputtering process	
UNIT IV	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 X ray diffraction techniques - thermo gravimetric analysis of nano materials	
UNIT V	9 Hours
APPLICATIONS	
Nano InfoTech: Information storage- nano computer, molecular switch, super chip, nano crystal, Nano bio technology: nano probes in medical diagnostics and biotechnology, Nano medicines, Targeted drug delivery, Bio imaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nano sensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sun barrier products - In Photostat, printing, solar cell, battery.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. G Timp, Nanotechnology, AIP press/Springer, 19992. Akhlesh Lakhtakia, The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations. Prentice- Hall of India (P) Ltd, New Delhi, 20073. William A. Goddard, Donald Brenner, Handbook of Nano science, Engineering, and Technology, CRC Press, 2012.4. Charles P. Poole Jr and Frank J. Owens, Introduction to Nanotechnology, Wiley Inter science, 20075. Guozhong Cao, Y. Wang, Nanostructures and Nano materials-Synthesis, Properties & Applications, Imperials College Press, 2011	

18ME032 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 international quality management 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.

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 - Dimensions of Quality - Quality Planning - Quality costs - Analysis Techniques for Quality Costs - Basic concepts of Total Quality Management - Historical Review - Quality Statements - Strategic Planning, Deming Philosophy - Crosby philosophy - Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen - Obstacles to TQM Implementation	
UNIT II	9 Hours
TQM PRINCIPLES	
Principles of TQM, Leadership Concepts, Role of Senior Management, Quality Council, Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits - Supplier Partnership - Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures	
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. DaleH.Bester filed, Total Quality Management, Pearson Education Inc., New Delhi, 2003
2. N.Gupta and B.Valarmathi, Total Quality Management, Tata McGraw-Hill Publishing Company Pvt. Ltd., New Delhi, 2009
3. James R.Evans and William M.Lidsay, The Management and Control of Quality, SouthWestern 2002
4. Dr.S.Kumar, Total Quality Management, Laxmi Publications Ltd. New Delhi, 2006
5. P.N.Muherjee, Total Quality Management, Prentice Hall of India, New Delhi, 2006

18GE0E1 ENTREPRENEURSHIP DEVELOPMENT I**3 0 0 3****Course Objectives**

- Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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 nature, scope, and types of entrepreneurship, and evaluate the role of entrepreneurial personality traits and processes in fostering economic development.
2. Apply creativity and innovation techniques such as lateral thinking, brainstorming, and reversal methods to develop viable business ideas through the generation of alternatives and analogies.
3. Infer the provisions of business laws to design a compliant framework for business formation and operations including contracts, partnerships, and company memoranda.
4. Assess ultrasonic testing techniques, including phased array and angle beam methods, to evaluate internal defects in structural and welded components.
5. Select the effective production systems and facility layouts to develop operational strategies that optimize plant location, capacity planning, inventory management, lean manufacturing, and Six Sigma principles.

Articulation Matrix

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

18GE0E2 ENTREPRENEURSHIP DEVELOPMENT II**3 0 0 3****Course Objectives**

- Evolve the marketing mix for promoting the product / services
- Handle the human resources and taxation
- Understand Government industrial policies / support provided and prepare a business plan

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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. Apply the marketing concepts including segmentation, positioning, and strategy formulation to identify the behavior of dynamic market environments
2. Interpret human resource practices, financial systems, and government initiatives to understand organizational behavior and policy impact
3. Demonstrate the implications of direct and indirect taxation systems on business decisions with support from real-time case examples
4. Analyze the institutional and financial support mechanisms provided by central, state, and local government bodies for business development
5. Formulate a comprehensive business plan covering capital planning, marketing, operations, HR, and financial viability assessment.

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	-	-	-	1	2	-	-
3	3		-	-	-	-	-	2	-	-	-	1	2	-	-
4	2	3	-	-	-	-	-	2	-	-	-	1	2	-	-
5	2	2	2	-	-	-	-	2	-	-	-	1	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.htm	

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	-	-
3	-	-	-	3	-	-	-	-	-	-	-	-	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 Environment, 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 ingress protection, Dust ingress protection, Altitude test, readability test. Electrical tests-EMI test, steady state electrical environment test. Test facility used for various test, Testing environments ,maintenance & calibration of testing equipment's, acceptance & rejection criteria based on test outcomes ,test report, NABL accreditation and its importance.

Total: 15 Hours

Reference(s)

1. Tomer Sharon , "Validating Product Ideas Through User Lean Research", Rosanfeld, 2016.
2. Dennis F.X. Mathaisel, "Engineering for Sustainability", CRC Press, 2013

18ME0XP 8D PROBLEM SOLVING METHODOLOGY**1 0 0 1****Course Objectives**

- To understand the 8D problem solving methodology.
- To implement 8D problem solving methodology using 7QC Tools.

Programme Outcomes (POs)

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

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 ISO 45001. Fire prevention – science of combustion, classes of fire, types of fire- fire detection and control- smoke and flame detector, alarm system, hydrant, sprinkler- portable extinguishers- selection and operation - emergency preparedness and mock drill.

Total: 15 Hours

Reference(s)

1. National Safety Council, Accident Prevention Manual for Industrial Operations, N. S. C. Chicago, 1988.
2. H.W Heinrich, Prevention Industrial Accident McGraw-Hill Company, New York, 1991.
3. IS 14489: - code of practice on occupational safety and health.
4. ISO 14001: - environment management system.
5. ISO 45001: - Health safety management system.
6. Handbook of fire technology, R S Gupta, orient blackswan, 2010.

18ME0XT MODELLING AND ANALYSIS OF UNDERWATER ROBOTS**1 0 0 1****Course Objectives**

- To understand the basics of underwater robots and its practical applications.
- To understand the design concepts and simulation of vehicle structure.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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/Raspberry pi/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

18GE0XA ETYMOLOGY**1 0 0 1****Course Objectives**

- To increase vocabulary and enhance use, knowledge, and understanding of the English language.
- To stimulate an appreciation for the English language, including how it developed, how new words enter the language, and how it continues to be dynamic.
- To demonstrate the importance of a broad-based vocabulary for effective oral and written communication.

Programme Outcomes (POs)

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

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 various forms of wordplay, idiomatic expressions, and etymological origins to enhance comprehension and effective use of English language conventions in professional contexts.
2. Analyze the structural components and origins of English words, to develop linguistic awareness and apply this knowledge to improve vocabulary and language precision.

Articulation Matrix

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

UNIT I**7 Hours****CONVENTIONS**

Acronyms, Abbreviations, Initializes, Jargon Neologisms - Idiomatic Expressions, Euphemisms Spoonerisms Malapropisms; Mondegreens - Words Derived from Latin - Words Derived from Greek - Words Derived from - Germanic/Anglo-Saxon - Abstract word Acronym - Affix Analogy - Antonym Apheresis - Blend word Assimilation - Colloquial language Clipped word

UNIT II

8 Hours

WORD ANALYSIS

Concrete word Derivative - Dialect Diminutive suffix - Dissimilation Doublet - Etymology Euphemism - Figurative word Homonym - Hybrid word Inflection - Informal language Infusion - Jargon Linguistics - Loan words Metathesis ; Modify - Philology Onomatopoeia - Romance language Prefix - Semantics - Root-base word - Suffix Slang - Word component Synonym

Total: 15 Hours

Reference(s)

1. Norman, Lewis. Word Power Made Easy, Goyal Publisher. Edition 2. 2014.
2. C T Onions. The Oxford Dictionary of English Etymology, Volume 11, Issue 1.70, Wynford Drive, Don Mills, Ont, Oxford University Press.1965.
3. Nurnberg W, Maxwell and Rosenblum, Morris, How to build a better Vocabulary, Completely Revised and Updated, Popular Library. 1961.

18GE0XB GENERAL PSYCHOLOGY**1 0 0 1****Course Objectives**

- To provide a basic understanding of psychology.
- Defining Psychology and the subject matter of psychology.
- To provide an awareness of various methods and branches of psychology.
- To explain social and work psychology of people and the need for mental health.

Programme Outcomes (POs)

- PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. Design solutions for complex engineering problems and design system 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.
- 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 foundational concepts of psychology, including the mind-body relationship and psychological methods, to understand human behavior and mental processes.
2. Integrate and assess motivational and intelligence theories to formulate strategies that address diverse human needs and cognitive differences in academic, workplace, and social environments.
3. Design and propose interventions or models that address social influence, group dynamics, and attitude change, based on a deep understanding of social cognition, stereotypes, prejudice, and discrimination.

Articulation Matrix

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

UNIT I **15 Hours**

GENERAL PSYCHOLOGY

Psychology - Introduction - Mind body relationship - Methods and Scope of Psychology -Motivation- Types of Needs- Motivational Cycle- Intelligence: Concept of Intelligence and IQ- measurement - Social psychology: individual behavior and group behavior - Group dynamics- group formation- social influence- social cognition, stereotypes- prejudice- discrimination - Definitions, formation of attitude, factors of attitude formation-change of attitude.

Total: 15 Hours

Reference(s)

1. Atkinson & Atkinson, Introduction to Psychology, 6th Ed McGraw-Hill Publications. 1975
2. Mishra, B. K, Psychology: The study of human behavior, 2nd Ed New Delhi: Prentice Hall of India Learning Pvt. Ltd. 2016.
3. Baron, R.A., Branscombe. N.R, Social Psychology, 14th Ed. New Delhi; Pearson Education. 2016
4. Morgan, C.T., King, R.A., Weisz, J.R., & Schopler, J. Introduction to Psychology, 7th Ed. New Delhi: Tata McGraw Hill. 1993

18GE0XC NEURO BEHAVIORAL SCIENCE**1 0 0 1****Course Objectives**

- To provide an introduction to the Cognitive Neuro Science of languages.
- To provide an understanding of the Cognitive 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.

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.

Course Outcomes (COs)

1. Apply the knowledge of the basic structure and function of human physiology and neurobiology to understand human behavior.
2. Apply the effects of neurochemicals and hormones on behavior and mental health.
3. Analyze the effectiveness of relaxation techniques and psycho-educational methods for behavior modification and promoting mental well-being.

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	3	-	-	-	2	-	2	-	-	-	2	1	-	-
3	2	-	-	-	-	3	-	3	-	3	-	3	1	-	-

UNIT I**15 Hours****NEURO BEHAVIOURAL SCIENCE**

Introduction to physiology - Anatomy - Neuro Biology - Psycho Neuro Science Behaviour and Hormones - Behaviour Modifications - Relaxation Therapy - Psycho Education for minds

Total: 15 Hours

Reference(s)

1. Beck, Robert. Handbook of Physiology. Vol I. Oxford University Press March 15,1996
2. Horon C Philip. Sexology and Mind. Academic Press. 1993
3. Blatteis M.Clark and Melvin J. Fregly. Handbook of Physiology Sect 4, Oxford University Press. March 15, 1996

18GE0XD VISUAL MEDIA AND FILM MAKING**1 0 0 1****Course Objectives**

- To acquire fundamental knowledge on development of filmmaking as an art
- To provide students a basic understanding of the techniques and nuances of visual medium
- To inculcate an ability to plan and produce a short film

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Analyze the significance of visual media and illustrate the key techniques used in visual communication.
2. Construct visual clippings using appropriate techniques and assess their effectiveness in conveying intended messages.

Articulation Matrix

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

UNIT I**15 Hours****ART OF FILMMAKING**

History of Cinema (Origin and Narrative) Cinema as a visual medium -Significance of Editing Styles of Editing Editing as a methodology (Hollywood's Invisible Editing) Technical Aspects of Editing (Final Cut Pro (FCP), AVID and Premiere Pro) - Basics of video production (pre-production to post-production) Different types of shots and angles - Film style and Narrative (Italian Neo-realism, Avant Garde, Russian Formalism, Alternative Cinema etc.,) Regional Cinema to National Cinema Basics of Script Writing (Double and Single Column) Basics of Video Production (script to screen) Final submission of a script for five minutes short film

Total: 15 Hours

Reference(s)

1. Monaco, James, *How to Read a Film: Movies, Media, and Beyond*. Auckland: OUP, 2009.
2. Belavadi, Vasuki, *Video Production*. India: OUP, 2013.

18GE0XE YOGA FOR HUMAN EXCELLENCE**1 0 0 1****Course Objectives**

- To know about the history and schools of yoga
- To know the difference between supreme consciousness and individual consciousness
- To apply the knowledge by the way of practice and introspection

Programme Outcomes (POs)

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

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.

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.

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 yoga techniques in their daily lives to improve overall health and well-being
2. Apply yoga techniques for increased focus, concentration, and mindfulness, leading to better stress management and emotional regulation
3. Analyze the origin, evolution, and contemporary relevance of Yoga, including the philosophies of major Yoga schools and the Eight Limbs of Yoga, to understand its role in holistic well-being.

Articulation Matrix

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

UNIT I**15 Hours****YOGA FOR HUMAN EXCELLENCE**

What is Yoga , History of Yoga - Yoga in todays scenario- Schools of Yoga - Eight Limbs of Yoga - Sathvic, Rajasic, Tamasic Foods and Thoughts - Science of Yoga Loosening Exercises - Yogasanas & Benefits - Super Brain Yoga - Surya Namaskar Standing Asanas - Sitting Asanas - Prone Asanas - Supine Asanas – Mudras Relaxation - Pranayama - Meditation

Total: 15 Hours

Reference(s)

1. Vethathiri Publications, Yoga Practices-2, Erode, 2012.
2. Iyengar B.K.S. Yoga: Wisdom & Practice, B.K.S. Iyengar, 2009.
3. Ramesh Partani, The Complete Secret, Ru Education, 2013.
4. <http://www.sarvyoga.com/>
5. <http://www.wikihow.com/Do-Superbrain-Yoga>

18GE0XF VEDIC MATHEMATICS**1 0 0 1****Course Objectives**

- To improve their calculation speed, analytical thinking and numerical 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.

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

Course Outcomes (COs)

1. Apply vedic sutras to perform fast arithmetic operations like addition, subtraction, and multiplication.
2. Demonstrate vedic methods to efficiently compute squares, square roots, cubes, and cube roots of numbers.
3. Implement vedic techniques to analyze and solve linear and quadratic equations in order to maximize computing accuracy and speed.

Articulation Matrix

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

UNIT I**15 Hours****VEDIC MATHEMATICS**

Addition- Subtraction- System of Multiplication- Squaring numbers- Cube roots- Square roots- Solution of simultaneous equations- Solutions of Quadratic equations

Total: 15 Hours**Reference(s)**

1. Dhaval Bathia, Vedic Mathematics, JAICO Publishing House, 29th Edition, Mumbai, 2014
2. Jagadguru Swami Sri Bharathi Krsna Tirthaji Maharaja, Vedic Mathematics, Motilal Banarsiidas Publishers Private Limited, New Delhi, 1997

18GE0XG HEALTH AND FITNESS**1 0 0 1****Course Objectives**

- To understand the fundamental concepts about physical fitness & its types, training and assessment of physical fitness.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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. Illustrate the need, types, and importance of physical fitness to promote lifelong health and well-being.
2. Develop yoga postures, pranayama, and meditation techniques to improve physical and mental health
3. Analyze the role of balanced diet and nutrition in maintaining a healthy lifestyle and identify preventive measures for common diseases.

Articulation Matrix

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

UNIT I **5 Hours****FITNESS**

Meaning & Definition, Need & importance of Physical fitness, Types Physical fitness - Exercise, Training and Conditioning and it is important

UNIT II **5 Hours****YOGA AND MEDITATION**

Meaning and definition; Principles of practicing; Basic Asana and it important; Pranayama and Meditation - Relaxation Techniques

UNIT III **5 Hours****NUTRITION AND BALANCE DIET**

Nutrition and Balance Diet: Needs and Important, Significant of Nutritional Food - Tips for balance diet. Common Diseases for IT professionals: Common diseases - cause prevention-First aid for common sports injuries.

Total: 15 Hours

Reference(s)

1. Anderson, Bob., Pearl, Bill.,&Burke, Edmund R., (2001). Getting in Shape Workout Programs for Men&Women. Mumbai: Jaico Publishing House
2. Baechle, Thomas. R, & Earle, Roger. W., (2000). Essentials of Strength Training and Conditioning. Champaign: Human Kinetics
3. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers
4. Singh, Hardayal, (1995). Science of Sports training. New Delhi: D.V.S. Publications
5. Begum, Raheena. M., (2002). A Textbook of Foods, Nutrition and Dietetics. New Delhi: Sterling Publishers Private Limited

**18GE0XH CONCEPT, METHODOLOGY AND
APPLICATIONS OF VERMICOMPOSTING**

1 0 0 1

Course Objectives

- To understand the importance of safe methods of treating solid wastes generated through various human activities
- To appreciate the skills / devices / practices associated with the compact procedures of biodegradation of unwanted solid residues.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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.

Course Outcomes (COs)

1. Apply the ecological roles of earthworms and sustainable practices in vermiculture to promote organic farming and waste management.
2. Design and maintain effective vermicomposting systems using appropriate equipment and methodologies to optimize biodegradation and humus production.
3. Apply market research, quality control, and strategic marketing techniques to promote vermiculture products, fostering small-scale and commercial ventures with a focus on environmental and economic impact.

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	-	-	1	1	1	2	-	-
2	3	1	2	-	1	-	2	-	-	1	1	1	2	-	-
3	2	1	2	-	1	-	2	-	-	1	1	1	1	-	-

UNIT I**15 Hours****VERMICOMPOSTING TECHNOLOGY**

Ecological roles and economic importance of earthworms - need for earthworm culture, scope and importance of vermiculture , limiting factors - types of worm culturing and the relative benefits Small scale and commercial methods: process & advantages , Vermicomposting equipment, devices, Design and maintenance of vermi bed - Products from vermiculture (matter & humus cycle), vermicastings in organic farming/horticulture - Marketing the products of vermiculture quality control, market research, marketing techniques , Applied vermiculture: use of urban solids & farm/ industrial residues for vermicomposting - Constraints of vermiculture and its future perspectives Artificial Earthworm as a standalone biodegradation assembly.

Total: 15 Hours**Reference(s)**

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.4
2. Vermiculture Technology; Earthworms, Organic Wastes and Environmental Management, 2011, Edited by Clive A Edwards, Norman Q Arancon & Rhonda Sherman, CRC Press
3. www.organicgrowingwithworms.com.au
4. New York Times , Scientists Hope to Cultivate and Immune System for Crops

18GE0XI BLOG WRITING**1 0 0 1****Course Objectives**

- To sharpen and improve writing skills, including draft writing, voice, and format.
- To develop general and global knowledge.
- To experiment with non-written forms of online communications, including images, audio and video.
- To be able to add content to your website without the assistance of a web designer.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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 principles of digital content writing to structure and develop engaging blog posts for targeted audiences.
2. Demonstrate effective use of language, tone, and storytelling techniques to convey ideas clearly and persuasively in blog format
3. Formulate ethical guidelines, copyright norms, and originality standards to publish and promote blog content across suitable digital platforms.

Articulation Matrix

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

UNIT I**7 Hours**

Concept: What is blog writing? Types of blog posts -personal experience, opinion, reviews, advice, news/updates. Focusing your blog - concept, audience, uniqueness, posts. Company blogs. Structure: Types of structure - inverted pyramid, feature article, list, story, other options. Creating effective openings. Planning a post.

UNIT II

8 Hours

Voice: Defining and achieving voice. Exploring various voices. Stylistic tips, rhythm, verbs, interesting words, senses, emphasis. Smartness and sarcasm. Reliability - accuracy, provability, specificity. Transparency about payments. Sample Blogs and Activities

Total: 15 Hours

Reference(s)

1. The Elements of Blogging: Expanding the Conversation of Journalism, by Mark Leccese and Jerry Lanson. (Taylor & Francis, 2015) ISBN: 978-1-13-802154-9. \$29.95 paperback.
2. Blogging Heroes, by Michael Banks. Choose 15 of the 30 interviews/profile segments to read, be sure to include the segments on Chris Anderson and Brian Lam.
3. Complete Guide to Blogging, Huffington Post

18GE0XJ INTERPERSONAL SKILLS**1 0 0 1****Course Objectives**

- To communicate and work effectively, both individually and in groups
- To be able to understand and manage ones own and others emotions
- To define and solve problems by making decisions about the best course of action.

Programme Outcomes (POs)

- PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 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.
- 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. Demonstrate effective interpersonal traits such as active listening, team collaboration, empathy, and emotional intelligence for enhanced workplace communication and interaction.
2. Implement conflict resolution strategies and decision-making techniques to handle negotiation, persuasion, and problem-solving in professional and team settings.

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	1
2	3	2	-	-	-	-	-	-	2	2	2	-	2	2	1

UNIT I**7 Hours****INTRODUCTION**

Conversational Skills - Active Listening - Team working Empathy - Emotional Intelligence

UNIT II

8 Hours

SKILLS

Conflict Resolution and Mediation skills - Decision making and Problem Solving - Negotiation and Persuasion skills

Total: 15 Hours

Reference(s)

1. Stephen P. Robbins, Phillip L. Hunsaker, Training in Interpersonal Skills, Pearson, 2015
2. Robert B. Cialdini, Influence: The Psychology of Persuasion, Harper Business; Revised Edition, 2006
3. Suzanne C De Janasz, Karen O Dowo & Beth Z Schneder, Interpersonal Skills in Organisations, McGraw-Hill Education; 5th Edition, 2014

18GE0XK COMMUNITY SERVICE AND LEADERSHIP**1 0 0 1****Course Objectives**

- Understand the role of National Service Scheme in community
- Identify the needs and problems of the community and involve in problem solving
- Develop competence required for group living and acquire leadership qualities.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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. Interpret the philosophy, objectives, and structure of NSS, and analyze the role of NSS activities in addressing community issues through effective mobilization and stakeholder engagement.
2. Develop leadership qualities and community service skills by participating in health, hygiene, sanitation, and entrepreneurship initiatives, aligning with national programs like Swachh Bharat Abhiyan.

Articulation Matrix

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

UNIT I	15 Hours
COMMUNITY SERVICE AND LEADERSHIP DEVELOPMENT	
Introduction and Basic Concepts of NSS: History-philosophy-aims & objectives of NSS- Emblem, flag, motto, song, badge- Organizational structure roles and responsibilities functionaries. NSS Programmes and Activities: Concept of regular activities, special camping, Day Camps-Basis of adoption of village/slums- Methodology of conducting Survey -Financial pattern of the scheme -Coordination with different agencies- Maintenance of the Diary. Community Mobilization: Mapping of community stakeholders-Designing the message in the context of the problem and the culture of the community-Identifying methods of mobilization-Youth-adult partnership. Health, Hygiene & Sanitation: Definition, needs and scope of health education- Food and Nutrition - Safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan). Entrepreneurship Development: Definition & Meaning - Qualities of good entrepreneur - Steps/ways in opening an enterprise -Role of financial and support service Institutions.	

Total: 15 Hours

Reference(s)

1. A Hand book on National Service Scheme, Anna University, Chennai, 2012
2. <http://nss.nic.in/intro.asp>
3. Delgado-Gaitan and Concha, The Power of Community: Mobilizing for Family and Schooling New York: Rowman & Littlefield Publishing, Inc. 2001
4. James Bailey, Guide to Hygiene and Sanitation in Aviation, World health organization, 2nd edition. 1980
5. Anuradha Basu, Mark Casson, Nigel wadeson and Bernard Yeung, The oxford hand book of entrepreneurship, Oxford Press. 2009

18GE0XL NATIONAL CADET CORPS**1 0 0 1****Course Objectives**

- To understand the importance of NCC and its organization.
- To realize the skills in the applications of drill and weapon training.
- To analyze the factors in National unity
- To identify the utility of smart materials in engineering applications.

Programme Outcomes (POs)

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

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

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

Course Outcomes (COs)

1. Demonstrate and apply drill and weapon handling skills accurately and safely during practical parade and training sessions.
2. Analyze the role of NCC in promoting national integration and addressing social issues through cadet activities.
3. Demonstrate appropriate leadership and disaster response strategies during emergencies.

Articulation Matrix

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

UNIT I**7 Hours****NCC STRUCTURE AND TRAINING**

NCC ORGANIZATION: National Cadet Corps: Aim and Objectives - Administrative and Organizational pattern - NCC flag and NCC song - Duties, Responsibilities and Conduct by NCC Cadets - Badges of ranks in NCC and Armed forces- Types of NCC camps - Eligibility conditions for writing B and C certificate examinations. Cadet welfare society and Career opportunities for NCC cadets.

DRILL AND WEAPON TRAINING Drill: Aims of drill - Types of drill - Foot drill, Arms drill and Ceremonial drill. Word of commands, Guard of honour. Weapon training - Rifles used in NCC: Parts and Characteristics of 0.22 and INSAS - Stripping, Assembling and Cleaning of weapons.

NATIONAL INTEGRATION AND SOCIAL AWARENESS National Integration: Introduction - Constitution of India- Importance and Necessity - Factors affecting National integration - Role of NCC in National integration. Social service and its need - Rural development programs - NGOs role and Contribution - Social Security schemes.

UNIT II **8 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

PERSONALITY DEVELOPMENT AND LEADERSHIP Personality Development: Introduction - Factor influences in personality development. Leadership: Leadership traits and Skills - Indicator of good leader - Honour code concept - Type of leaders - Case studies of effective leader.

DISASTER MANAGEMENT AND FIRST AID Disaster types - Natural and Manmade disasters. Role of NCC cadets in disaster management. Civil defense: Civil defense measures - Civil defense services. First aid: First aid kits and Equipment's - First aid for snake bite, Sun stroke and Drowning - Respiration -Types of respiration.

Total: 15 Hours

Reference(s)

1. Cadets Hand book Common subject, DG NCC, New Delhi.
2. Cadets Hand book Special subject, DG NCC, New Delhi
3. Misra R.C and Sanjaykumar Mishra, A HAND BOOK OF NCC(English), Kanti Prakashan, 2016
4. Gupta R. K, NCC: Handbook of NCC Cadets for A, B and C Certificate Examinations (English) RPH Editorial Board, 2018.

18GE0XM NEW AGE INNOVATION AND ENTREPRENEUISHIP**1 0 0 1****Course Objectives**

- To make the participants understand as to how to get along with the task of setting independent business units and on the various facets of running a business
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing a business opportunity.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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. Apply foundational concepts of entrepreneurship to identify opportunities and develop effective startup strategies
2. Analyze the financial, legal, and ethical challenges involved in launching and sustaining a new venture.
3. Design a comprehensive business plan incorporating market strategy, funding sources, IPR, and talent management for a new-age startup.

Articulation Matrix

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

UNIT I **15 Hours**

NEW AGE INNOVATION AND ENTREPRENEURSHIP

Introduction to Entrepreneurship - Opportunity Identification ideation -M V P Positioning as an Entrepreneur Starting own Business - Developing Effective Business Model - Industry and Competitor Analysis - Building Business Plan, Mentoring Session with Investors- Legal and Ethical Foundation for Startup. Types of startups and licensing systems - MSME -Evaluating the Financial Strength of a New Venture/Project - Getting Funding - Types of Sources VCs, Angel funding, PE etc. -Marketing Strategies for New Ventures - IT Systems - IPR - Strategies for New Venture Growth - Talent Acquisition and Management for New Ventures - Valuation Challenge in Entrepreneurship – Intrapreneurship Sustainability - Exit strategies and Start-up trends in India.

Total: 15 Hours

Reference(s)

1. Kathleen R. Allen, Launching New Ventures, South-Western Cengage Learning, 6th Edition, 2012
2. Alex Osterwalder and Yves Pigneur, Business Model Generation, published by the authors, 2010
3. Branson. R. Business stripped bare New York, Penguin books, 2011
4. Moris MH, Kuratko DF and Covin JG, Corporate entrepreneurship and innovation, 3 edition, Mason, Oh; CENGAGE/SOUTH WESTERN publisher, 2011

18GE0XN DISRUPTIVE INNOVATION BASED STARTUP ACTIVITIES**1 0 0 1****Course Objectives**

- To make the participants understand as to how to get along with the task disruption led innovations.
- To get the budding young entrepreneurs to appreciate the structured knowledge of the dynamics of operationalizing creativity-based disruption strategy.

Programme Outcomes (POs)

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Develop idea generation and creative communication skills that lead to disruptive innovation (DI)-based startup activities.
2. Innovate management concepts in disruptive innovation (DI)-based entrepreneurship to develop new business models and bring new products and services to market.
3. Analyze the application of disruptive innovation (DI) theories to complex problems and opportunities to identify the right customers.

Articulation Matrix

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

UNIT I**15 Hours****DISRUPTIVE INNOVATION**

Creativity linked innovation, Differences between Disruptive & incremental Innovations - Historical, theoretical, and practical evolution of disruptive innovation (DI). - Idea generation & communication of creativity leading to DI. Innovation management concepts in DI based entrepreneurship - How do firms bring in new business models and get new products and services to the market. Investor preferences in core versus new or disruptive business models - disruptors and the disrupted frameworks for assessing company's capabilities and rethinking product, market and strategy - Right customers for DI: strategy in a world that is changing so rapidly, Application of disruptive theories to complex problems and opportunities.

Total: 15 Hours

Reference(s)

1. <https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-5885.2005.00177.x>
2. <http://www.brinq.com/workshop/archives/2005/01/08/what-is-disruptive-innovation>
3. <https://hbr.org/2006/12/disruptive-innovation-for-social-change>

18GE0XO SOCIAL PSYCHOLOGY**1 0 0 1****Course Objectives**

- To provide a basic understanding of social psychology.
- Defining psychological & physical changes during puberty age.
- To provide an awareness of various psychological problems and social problems.
- To explain social and work psychology of people and the need for mental health.

Programme Outcomes (POs)

- PO1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO2. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO3. Design solutions for complex engineering problems and design system 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.
- 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. Analyze the basics of human behavior in the workplace and society to understand social roles, attitudes, and interpersonal dynamics.
2. Apply psychological principles to recognize and manage common psychological, physical, and social problems in daily life.
3. Develop effective interpersonal and social skills for improved personal relationships and responsible social behavior.

Articulation Matrix

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

UNIT I**7 Hours****INTRODUCTION**

Introduction - Ice breaker - Time Line - Tasks and Challenges of the age(Erik Erikson)Physical changes - Introduction to Reproductive Health - Reproductive Organs - Menstruation - Changes during Puberty - Abortions - Contraception - Difference between Sex and Gender - Introduction to the origins of Patriarchy - Gender.

UNIT II

8 Hours

PSYCHOLOGY

Developmental changes - Attraction - Friendship - Differences and Similarities - Images of Beauty and Body Image -Introduction to Media-Feedback - Sexuality - Boundaries Relationships - Marriage - Love - Emotional Health - Sexual Abuse and Safety - Role of Media - Abortions, Contraception, Wrapping up the Course.

Total: 15 Hours

Reference(s)

1. Baron, R. A., Branscombe, N. R. (2016). Social Psychology, 14th Ed. New Delhi; Pearson Education
2. Morgan, C. T., King, R. A., Weisz, J. R., & Schopler, J. (1993). Introduction to Psychology, 7th Ed. New Dehi: Tata McGraw Hill.

18ME0YA 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.

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 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	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
2	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
3	2	2	-	2	-	-	-	-	-	-	-	1	-	2	-
4	2	2	3	-	-	-	-	-	-	-	-	1	-	2	-
5	2	2	3	-	-	-	-	-	-	-	-	1	-	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)	
<ol style="list-style-type: none">1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,20102. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,20063. Panneerselvam R., Production and operations management, Heritage Publishers, 20064. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009	

18ME0YB 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.

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.

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

UNIT I **8 Hours**

SAFETY MANAGEMENT

Concepts - Evolution, International Labour Organization (ILO), National Safety Council, Techniques - Job Safety Analysis (JSA), Safety survey, Safety inspection, Safety Sampling, Accident Reporting and Investigation - Concept of an accident, Accident causation models, cost of accident, investigation, Safety Performance Monitoring - Safety indices.

UNIT II **10 Hours**

SAFETY AND LAW

Factory Act 1948-Safety and Health chapters, Tamil Nadu Factories Rules- Safety and Health chapters, Environment and Pollution Laws, ,Building and other construction works act 1996, Electricity Rules.

UNIT III **10 Hours**

SAFETY IN ENGINEERING INDUSTRIES

Safety in machine shop,- Principles of machine guarding - Personal protective equipment- Safety in handling industrial gases - Safety in cold forming and hot working of metals- Safety in finishing, inspection and testing, heat treatment, electro plating, leak test, radiography.

UNIT IV **9 Hours**

SAFETY IN CHEMICAL INDUSTRIES

Safety in process design, unit operations, pressure vessel, heat exchanger, safety valves -Plant commissioning and inspection, pressure vessel, Plant maintenance and emergency planning, management of maintenance HAZOP study.

UNIT V **8 Hours**

SAFETY IN CONSTRUCTION INDUSTRY

Construction regulations, contractual clauses, permit to work, - Education and training-Hazards of construction and prevention- excavation, scaffolding, dismantling, road works, construction of high rise buildings - Working at heights,-Working on fragile roofs, work permit systems-Construction machinery, cranes, chain pulley blocks, earth moving equipment, conveyors- Manual handling, Safety in demolition work, - Safety in confined spaces

FOR FURTHER READING

Case Studies- Major accidents at Flixborough, UK, Seveso, Italy, Victoria Dock, India, Bhopal, India.

Total: 45 Hours

Reference(s)

1. Blake R.B., Industrial Safety, Prentice Hall, Incorporated, New Jersey,1973.
2. National Safety Council, Accident Prevention Manual for Industrial Operations, Chicago, 1988
3. Subramanian V., The Factories Act, 1948, with Tamil Nadu Factories Rules , 1950, Madras
4. Environmental Pollution Control Act, 1986
5. BOCW Act,1996, Madras Book agency, Chennai-1
6. Explosive Act, 1884, Eastern Book Company, Lucknow -266 001.

18ME0YC 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

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.

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 principles and objectives of planned maintenance activities to establish effective maintenance systems and economic planning strategies.
2. Formulate different maintenance categories and schedules to implement the lubrication techniques and Total Productive Maintenance (TPM) strategies
3. Analyze condition monitoring methods using temperature, noise, vibration, and wear parameters to assess equipment health and optimize maintenance scheduling.
4. Investigate failure causes in mechanical systems and apply suitable non-destructive testing and repair methods to restore component functionality.
5. Implement computer-aided maintenance management systems (CAMMS) for effective resource planning, spare parts tracking, and performance reporting.

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

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

18ME0YD BASICS OF NON-DESTRUCTIVE TESTING**3 0 0 3****Course Objectives**

- To learn different surface inspection techniques.
- To provide knowledge on sub surface testing methods.
- To impart knowledge on ultrasonic testing method.
- To provide knowledge on radiography testing method.
- To study various special non-destructive testing methods.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Apply visual inspection and liquid penetrant testing techniques to detect surface discontinuities in engineering components.
2. Analyze subsurface flaws in materials using magnetic particle testing and eddy current inspection techniques.
3. Evaluate internal flaws in structural and welded components using ultrasonic testing techniques, including phased array and angle beam methods.
4. Interpret radiographic testing results using X-rays and gamma rays to characterize internal defects from both film and digital radiographic data.
5. Design appropriate non-destructive testing approaches using advanced techniques such as acoustic emission, infrared thermography, leak testing, and laser-based methods for specialized application

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

UNIT I	9 Hours
SURFACE TECHNIQUES Introduction and Scope of NDT, Discontinuities and Defects in various manufactured Components, Various physical characteristics of materials and their applications in NDT, Relative merits and limitations of NDT, Types of NDT techniques, Visual or Optical Testing - Direct and remote visual inspection and Aides. Liquid Penetrant Testing (LPT) Principles - Types and properties of liquid penetrants and developers - Preparation of test materials - Advantages and limitations - Application of penetrants to parts - Fluorescent penetrant test	
UNIT II	9 Hours
SUB SURFACE TECHNIQUES Magnetic Particle Testing (MPT) - Principles, applications, magnetization methods, magnetic particles - Dry particle technique and Wet fluorescent particle technique - Advantages and Limitations. Eddy Current Inspection - Principle, Methods, Equipment for ECT, Techniques, Sensitivity, Application, scope and limitations	
UNIT III	9 Hours
ULTRASONIC TESTING Ultrasonic Testing (UT) - Principle, Types and characteristics of Ultrasonic waves - Attenuation, Couplants, Probes - Inspection methods - Pulse echo, Transmission and Phased Array techniques (PAUT), Types of scanning and displays - Angle beam inspection of welds - Calibration of ASTM Test blocks, International Institute of Welding IIW) reference blocks - Applications	
UNIT IV	9 Hours
RADIOGRAPHY TESTING Radiographic testing (RT) -Principle, Sources of X-rays and Gamma rays and their characteristics - Absorption, scattering, Filters and screens, imaging modalities - Film radiography and Digital Radiography - Problems in shadow formation, Exposure factors, film handling and storage- Inverse square law, Exposure charts, and Radiographic equivalence, Penetrometers - Safety in radiography- Applications	
UNIT V	9 Hours
SPECIAL NDT TECHNIQUES Acoustic Emission Testing (AET) Principle - Instrumentation and applications, advantages and limitations. Infra-Red Thermography (IRT) - Principle, Techniques and applications. Leak Testing - Principle, Testing Procedure and applications. LASER Stereography- Typical applications- Requirements - advantages and disadvantages.	
Total: 45 Hours	
Reference(s)	
1. Charles J. Hellier, "Handbook Of Nondestructive Evaluation", McGraw-Hill Education; 2 edition 2012. 2. Baldev Raj, Jayakumar T, Thavasimuthu M, "Practical Non-Destructive Testing", Narosa Publishing, 2009. 3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 2001. 4. Mc Gonnagle W T, "Non-Destructive Testing", McGraw Hill Book Co., 1988 5. Louis Cartz, "Non-Destructive Testing", ASM International, Metals Park Ohio, US, 1995. 6. https://onlinecourses.nptel.ac.in/noc19_mm07/course	

18ME0YE 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.

Course Outcomes (COs)

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

Articulation Matrix

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

UNIT I 9 Hours

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II 10 Hours

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III 7 Hours

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV 8 Hours

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V 11 Hours

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 <http://www.springer.com/978-1-4939-2112-6>
6. www.grabcad.com, www.all3dp.com

18ME0YF WORK STUDY AND ERGONOMICS

3 0 0 3

Course Objectives

- To develop concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems
- To study the existing method, compare and propose a new method
- To provide the usage of the various tools and techniques used in work measurement
- To develop basic ideas of ergonomics and its design
- To develop concepts related Man-Machine Interfaces and Design of Displays and controls

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Apply work study principles to calculate the basic work content of a job and find ways to improve efficiency of production system.
2. Implement job task analysis to assess stress, fatigue, and musculoskeletal risks, and design work systems to mitigate these risks effectively.
3. Illustrate time study techniques to determine basic, allowed, and standard times for better time management in job tasks.
4. Analyze ergonomic principles in design to improve human-machine interactions, reduce fatigue, and improve productivity.
5. Develop man-machine interfaces and display/control systems in accordance with ergonomic standards and guidelines to enhance usability 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	-	-	-	-	-	-	2	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	2	-
4	2	3	-	-	-	2	-	-	-	-	-	-	2	2	-
5	2	2	3	-	-	2	-	-	-	-	-	-	2	2	-

UNIT I 8 Hours

PRODUCTIVITY AND WORK STUDY

Definition of productivity, factors affecting productivity, definition, objective & scope of work study, human factors in work study, work study & management, work study & supervisor, work study & worker.

UNIT II 9 Hours

METHOD STUDY

Definition, objective & scope, charts to record movements in shop, process charts, flow process charts, Multiple activity charts, two handed process charts, SIMO chart, principles of motion economy

UNIT III 8 Hours

WORK MEASUREMENT

Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems. Time study: Definition, time study equipments, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, standard time determination

UNIT IV 10 Hours

INTRODUCTION TO ERGONOMICS

Introduction to Ergonomics: Human factors and ergonomics Physical Ergonomics: human anatomy, and some of the anthropometric, physiological and bio mechanical characteristics. Cognitive: mental processes, such as perception, memory, reasoning, Organizational ergonomics: optimization of socio-technical systems, organizational structures, policies, processes. Environmental ergonomics: human interaction with the environment.

UNIT V 10 Hours

MAN-MACHINE INTERACTION

Machine interaction cycle, Man-machine interfaces, Displays :factors that control choice of display, visual displays- qualitative displays; moving pointer displays, moving scale displays, digital displays Indicators, auditory displays, tactile displays. Factors affecting effectiveness of displays. Quantitative displays, check-reading displays, representational displays. Design guidelines for displays and controls. Standards for ergonomics in engineering and design, displays and controls.

Total: 45 Hours

Reference(s)

1. S. Dalela and Sourabh,Work Study and Ergonomics. Standard publishers 2013
2. Wesley Woodson, Peggy Tillman and Barry Tillman,Human Factors Design Handbook, McGraw-Hill; 2ndedition, 1992
3. Ralph M. Barnes,Motion and Time Study, Wiley International, 7th Edition
4. Mark S. Sanders and Ernest J. McCormick ,Human Factors in Engineering Design, 4th edition, 2013
5. B. Niebel and Freivalds, Niebel, Methods Standards and Work Design, McGraw-Hill, 12th Edition, 2009,

18ME0YG METROLOGY IN INDUSTRY**3 0 0 3****Course Objectives**

- To familiarize the concept of metrology and measurement standards.
- To learn about the linear and angular measurements.
- To impart knowledge on measurement of straightness and surface roughness.
- To educate on the screw thread terminologies and comparator.
- To emphasize measurement procedure for machine tool metrology.

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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.

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

Course Outcomes (COs)

1. Illustrate the fundamental principles of metrology, types of measurement methods, instrument characteristics, and the importance of calibration and care.
2. Compare various linear and angular measuring instruments based on their suitability for different industrial applications
3. Develop methods to measure geometrical and dimensional tolerances, including surface finish, straightness, roundness, and cylindricity using standard comparators
4. Formulate appropriate measurement strategies for evaluating threads, gears, and radius using form measurement instruments.
5. Validate advanced measurement systems including coordinate measuring machines, interferometry, and machine tool alignment techniques for achieving precision inspection.

Articulation Matrix

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

UNIT I	7 Hours
INTRODUCTION TO METROLOGY	
Definition, types, need for inspection, methods of measurement, selection of instruments, errors in measurement, units - Characteristics of measuring instrument : sensitivity, Accuracy, Readability, Reliability, Repeatability and Reproducibility - Measurement standards, calibration, care taking of measuring instruments.	
UNIT II	8 Hours
LINEAR AND ANGULAR MEASUREMENTS	
Linear metrology: Steel rule, calipers, vernier caliper, vernier height gauge, vernier depth gauge, micrometers, slip gauge, limit gauging and its classification - Limits, fit and tolerances. Angular Measurements: Bevel protractor and Sine bar.	
UNIT III	10 Hours
MEASUREMENT OF GEOMETRICAL AND DIMENSIONAL TOLERANCE	
Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity. Measurement of surface finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, roughness measurement methods, precautions in measurement. Comparator: Features of comparators, classification of comparators, different comparators, advanced comparators.	
UNIT IV	10 Hours
FORM MEASUREMENT	
Screw thread metrology: Introduction, screw thread terminology, errors in thread - External screw thread measurement: Tool makers microscope, Floating carriage micrometer and pitch gauge - Internal thread measurement: Taper parallels and roller method. Gear measurement: Introduction, types of gears, gear terminology, gear tooth vernier caliper, profile projector, Parkinson gear tester - External and Internal Radius measurement.	
UNIT V	10 Hours
ADVANCED AND MACHINE TOOL METROLOGY	
Digital devices - Interferometry: Principle of interference, interference patterns, NPL flatness interferometer - Coordinate Measuring: Basic concept, Types, Constructional features, Probes and Accessories - Computer Aided Inspection: Machine Vision System - Measurement of Temperature: Infrared Thermometer - Machine tool alignment test on Lathe, Drilling and Milling machine.	
Total: 45 Hours	

Reference(s)

1. R. K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 2009.
2. K.J. Hume, Engineering Metrology, Macdonald and Co. (publisher) London, 1970.
3. Czichos (Ed), The Springer handbook of metrology and Testing, 2011.
4. Jay. L. Bucher (ed), The Metrology Hand book- American Society for Quality, 2012.
5. Smith GT, Industrial Metrology, Springer, 2002
6. https://onlinecourses.nptel.ac.in/noc18_me62/

18ME0YH PLANT LAYOUT AND MATERIAL HANDLING**3 0 0 3****Course Objectives**

- To provide knowledge in Selection of plant locations.
- To offer knowledge in developing layout for various industries incorporating the safety aspects.
- To provide knowledge on creating and maintaining safe working environment
- To impart knowledge in Manual Material Handling and Lifting Tackles
- To educate on Manual Material Handling equipment

Programme Outcomes (POs)

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

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

PO3. Design solutions for complex engineering problems and design system 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

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

Course Outcomes (COs)

1. Analyze plant location based on land, utilities, safety, and future expansion for selecting suitable industrial sites.
2. Design safe plant layouts for industries by planning equipment placement, emergency systems, and access routes.
3. Demonstrate effective implementation of ventilation, lighting, and 5S techniques to maintain workplace safety.
4. Develop manual handling methods and lifting tackles for safe movement of heavy and hazardous materials.
5. Implement appropriate material handling equipment based on application, safety, and maintenance needs.

Articulation Matrix

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

UNIT I	9 Hours
PLANT LOCATION	
Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions-Safe location of storage of chemicals in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine - explosives and propellants.	
UNIT II	9 Hours
PLANT LAYOUT	
Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powder manufacturing, fireworks and match works.	
UNIT III	9 Hours
PLANT ATMOSPHERE	
Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards-Housekeeping, principles of 5S.	
UNIT IV	9 Hours
MANUAL MATERIAL HANDLING AND LIFTING TACKLES	
Preventing common injuries, handling specific shape machines and other heavy objects - accessories for manual handling - problems with hazardous materials - storage and handling of cryogenic liquids -shipping and receiving - personal protection ergonomic considerations. Fiber rope and wire rope, types, strength and working load inspection, - slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection.	
UNIT V	9 Hours
MATERIAL HANDLING EQUIPMENTS	
Hoisting apparatus - cranes, types, design and construction, guards and limit devices, signals, maintenance safety rules, inspection checklist - conveyors, types, applications. Powered industrial trucks, principles, operators selection and training and performance test, maintenance, electric trucks, gasoline operated trucks, LPG trucks - power elevators, types of drives, requirements for the physically challenged, types-Escalator, safety devices and brakes, moving walks - man lifts, construction, brakes, inspection.	
	Total: 45 Hours
Reference(s)	
1. M.P. Alexandrov. Material handling equipment Mir Publishers, Moscow, 1981	
2. Accident prevention manual for industrial operations N.S.C., Chicago, 2012	
3. Spivakovsky, Conveyors and related Equipment, Vol.I and II Peace Pub. Moscow, 1985.	
4. Apple M. James Plant layout and material handling, 3rd edition, John Wiley and sons.1978	
5. Encyclopedia of occupational safety and health, ILO Publication, 2009	
6. Industrial ventilation (A manual for recommended practice), American conference of Governmental Industrial Hygiene, USA, 1984	

18ME0YI 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	1	-	-	-
2	2	3	-	-	-	-	2	-	-	-	-	1	1	-	-
3	2	2	2	-	-	-	-	-	-	-	1	-	2	-	-
4	2	2	2	-	-	-	2	-	-	-	-	1	1	2	-
5	2	2	2	-	-	-	-	-	-	-	1	-	2	-	-

UNIT I	9 Hours
PRINCIPLES AND PROBLEM IDENTIFICATION	
Engineering design- introduction and definition, Considerations of a good design, Engineering design interfaces, Principles of engineering design, Problem identification, Design process, Product Design Specification (PDS) criteria, Content of a PDS.	
UNIT II	9 Hours
CONCEPT GENERATION AND SELECTION	
Identifying customer needs, 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, five basic patterns of decision making, decision making based on state of knowledge, 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), Design review, Value analysis/engineering, Factor of safety, Materials selection, break even analysis - problem, cost evaluation, Elements of cost, ISO concepts.	
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, patenting process.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Ken Hurst, Engineering Design Principles, Elsevier Science and Technology Books, 2004.2. George E Dieter, Engineering Design, Tata McGraw Hill publishing Company Pvt Ltd, New Delhi, 20083. Daniel E. Whitney, Mechanical Assemblies: Design Manufacture and Role in Product Development, Oxford University, Press, 20084. K. Otto, Product Design, Pearson Publications, 2005.5. Richard Birmingham, Graham Cleland, Robert Driver and David Maffin, Understanding Engineering Design, Prentice Hall of India, 19976. www.patentoffice.nic.in	

18ME0YJ OIL HYDRAULICS AND PNEUMATICS

3 0 0 3

Course Objectives

- To impart knowledge on various types of hydraulic pumps and actuators
- To learn about various hydraulic components and its working functions
- To provide knowledge on the selection of hydraulic components
- To learn about various types of pneumatic components and servo systems
- To emphasize 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.

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

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

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

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

Course Outcomes (COs)

1. Illustrate the construction and working principles of hydraulic pumps, motors, and actuators by applying Pascal's Law in fluid power systems.
2. Investigate the functions of hydraulic valves, accumulators, and intensifiers to infer their influence on pressure, flow, and direction control within a fluid power system.
3. Apply appropriate selection strategies for hydraulic components including pumps, actuators, valves, hoses, and reservoirs based on operational requirements and load conditions.
4. Analyze the construction and working principles of pneumatic components such as compressors, FRL units, valves, actuators, and servo systems used in automation applications.
5. Design fluid power circuits such as speed control, synchronization, and sequential circuits using methods like cascade and stepper sequencing to simulate real-world industrial 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	-	-	-	-	-	-	1	-	2	-	-	-	2
3	-	-	2	1	-	-	-	-	1	-	2	-	-	-	2
4	3	-	-	-	-	-	-	-	1	-	2	2	-	-	2
5	3	2	1	-	2	-	-	-	1	-	2	2	-	-	1

UNIT I**10 Hours****HYDRAULIC PUMPS AND ACTUATORS**

Introduction to fluid power system - Applications of Pascal's Law - Hydraulic pumps - Pumping theory, classification - Gear pump, Vane pump, piston pump, construction and working principles - Fluid power Actuators - Single acting, Double acting, cushioning and telescopic cylinder, construction and working principles. Gear Motors, Vane motors, Piston motors.

UNIT II**10 Hours****HYDRAULIC COMPONENTS**

Direction control valve - check valve, shuttle valve, 3/2, 4/2 and 4/3 way valve and solenoid valve - Actuation methods. Pressure control valves-pressure relief valve, compound pressure relief valve, pressure reducing valve, unloading valve, sequence valve, counterbalance valve. Flow control valves- types. Accumulators and intensifier - Types.

UNIT III**8 Hours****SELECTION OF HYDRAULIC COMPONENTS**

Selection factors-Selection of pumps. Actuators - cylinders, motors versus load - Piston rod buckling. Selection of Hydraulic pipe and hoses, valves, reservoir, filters, Accumulators and intensifiers.

UNIT IV**9 Hours****PNEUMATIC COMPONENTS**

Compressors- Filter, Regulator, Lubricator (FRL) unit, mufflers. Valves- direction control valves - shuttle valve, two way air piloted valve, push button valve, quick exhaust valve, lever control valve and solenoid valve - Pneumatic actuators. Servo system - Hydro mechanical, Electro hydraulic and proportional valve.

UNIT V**8 Hours****DESIGN OF FLUID POWER CIRCUIT**

Fluid power circuits- Speed control circuits, synchronizing circuit, sequential circuit and design for simple application using cascade and stepper sequencer method. Application of Accumulator and Intensifier circuit.

FOR FURTHER READING

Design and simulation of simple circuit using Simulation software. Causes and trouble shootings of fluid power system.

Total: 45 Hours

Reference(s)

1. Anthony Esposito, Fluid power with applications, 7th Edition, Pearson Education, New Delhi, 2013
2. Andrew Parr, Hydraulics and Pneumatics, 2nd Edition, Butterworth Heinemann, New Delhi, 2006.
3. S.R Majumdar, Oil Hydraulic Systems: Principles and Maintenance, McGraw Hill publishing company Pvt. Ltd. 28th Edition New Delhi, 2017.
4. S.R.Majumdar, Pneumatic systems-Principles and maintenance, McGraw Hill publishing company Pvt. Ltd., New Delhi, 2017.
5. S.Ilanga Introduction to Hydraulics and Pneumatics, 3rd Revised Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2017.

18ME0YK ENERGY AUDITING AND MANAGEMENT**3 0 0 3****Course Objectives**

- To emphasize on the concept of energy management and its importance
- To impart the knowledge on energy auditing and instrument selection skills
- To learn about the energy management tools and financial analysis
- To perform an energy efficiency assessment in thermal systems
- To measure the performance and efficiency of electrical utilities

Programme Outcomes (POs)

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

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

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 energy management and policy to assess energy consumption patterns and recommend renewable and energy-efficient solutions.
2. Implement energy auditing techniques and methodologies to identify conservation opportunities in industrial systems such as boilers, HVAC, and compressed air systems.
3. Investigate financial analysis techniques, including cash flow, NPV, ROI, and IRR, to evaluate the cost-effectiveness of energy management initiatives.
4. Analyze energy performance and efficiency improvement opportunities in thermal utilities such as boilers, furnaces, pumps, and HVAC systems, with a focus on steam distribution and recovery systems.
5. Compare the efficiencies and performance of electrical systems, including motors, lighting, and power factor improvement, to optimize energy consumption in compliance with the Electricity Act 2003.

Articulation Matrix

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

UNIT I	8 Hours
GENERAL ASPECTS OF ENERGY MANAGEMENT	
Current energy scenario - India and World, Current energy consumption pattern in global and Indian industry, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy and environment, Need of Renewable and energy efficiency.	
UNIT II	9 Hours
ENERGY AUDITING	
Energy audit - need, types of energy audit, Components of energy audit, Energy audit methodology, Instruments, equipment used in energy audit, Analysis and recommendations of energy audit - examples for different applications, Energy audit reporting. Energy conservation opportunities in boiler and steam system, furnace, HVAC system, pumping system, cooling tower and compressed air system.	
UNIT III	8 Hours
ENERGY ECONOMICS	
Importance of energy management, Financial analysis techniques - cash flow, discount rate, simple payback period, Net present value (NPV) and cash flow, Return on Investment (ROI) and Internal Rate of Return (IRR), life cycle costing.	
UNIT IV	10 Hours
ENERGY EFFICIENCY IN THERMAL UTILITIES	
Energy performance assessment and efficiency improvement of boilers, furnaces, heat exchangers, fans and blowers, pumps, compressors and HVAC systems. Steam distribution, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.	
UNIT V	10 Hours
ENERGY EFFICIENCY IN ELECTRICAL MOTOR AND LIGHTING SYSTEM	
Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Distribution and transformer losses. Electrical motors-types, efficiency and selection. Speed control, Energy efficient motors. Electricity Act 2003. Lighting - Lamp types and their features, recommended illumination levels, lighting system energy efficiency.	
FOR FURTHER READING	
Cogeneration - need, applications, advantages, classification, the cogeneration design process. Waste heat recovery - classification and application, potential for waste-heat recovery in industry, commercial WHR devices, saving potential.	
	Total: 45 Hours
Reference(s)	
1. Albert Thumann, Terry Niehus, William J. Younger, <i>Handbook of Energy Audit</i> , The Fairmont Press Inc., 9th Edition, 2013.	
2. Wayne C. Turner, Steve Doty, <i>Energy Management Handbook</i> , The Fairmont Press Inc., 6th Edition, 2007.	
3. Abbi Y. A., Jain Shashank, <i>Handbook on Energy Audit and Environment management Press</i> , TERI, New Delhi, 2006.	
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 2, 3 & 4 Bureau of Energy Efficiency, Govt. of India.	
5. Anthony L Kohan, <i>Boiler Operator's Guide</i> Fourth Edition, McGraw Hill, 4th Edition, 1997.	
6. http://www.aipnpsc.org/GuideBooks.aspx	

18ME0YL LEAN SIX SIGMA**3 0 0 3****Course Objectives**

- To acquire the knowledge to deliver consistently high quality and value added products and services to the customers in a lean environment
- To introduce quality management concepts of industrial processes through Six Sigma
- To develop the ability to define and measure the intensity of the industrial problems
- To analyse and improve the industrial processes
- To design and control the industrial 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.

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 the Toyota Production System and 5S methodology to identify and minimize manufacturing wastes.
2. Assess the framework of Six Sigma and its personnel, project, and process requirements to improve organizational efficiency and quality.
3. Apply the lean tools such as SIPOC, Value Stream Maps, and Pareto charts to identify improvement opportunities in manufacturing systems.
4. Analyze process data using tools like cause-and-effect diagrams and scatter plots to determine root causes and implement improved solutions through PICK charts.
5. Develop control techniques and Design for Lean Six Sigma (DFLSS) tools including QFD, FMEA, and DOE to sustain and standardize process improvements.

Articulation Matrix

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

UNIT I	9 Hours
LEAN MANUFACTURING	
History evolution - Power laws of speed - Toyota production system - Lean manufacturing overview - Pull production and Cellular manufacturing, Obstacles of lean; Over production, Waiting, Work in progress, Transportation, Inappropriate processing, Excess motion or ergonomic problems, Defective products, Under utilization of employees - Just in time manufacturing - 5S workplace maintenance.	
UNIT II	9 Hours
SIX SIGMA	
Difference between six sigma and TQM - Elements of successful deployment - Personnel requirements: Developing a training plan, Training needs analysis, Hierarchy of staffs - Process improvement: Elimination of variation, improvement of process flow and speed - Customer focus - Project selection - 5 laws of Six sigma - DMAIC problem solving.	
UNIT III	9 Hours
DEFINE AND MEASURE STAGES	
Objectives of Define - Project definition - Process definition - Team formation - Tools: SIPOC diagram, Value stream maps. Objectives of Measure - Process definition - Metric definition - Process baseline estimation - Measurement system analysis - Tools: Time value maps, Pareto charts.	
UNIT IV	9 Hours
ANALYSE AND IMPROVE STAGES	
Objectives of Analyse - Value stream analysis - Analysing source of variation - Determining process drivers - Tools: Cause and effect diagrams, Scatter plots. Objectives of Improve - Defining new process - Assessing benefits of proposed system - Implementation and verification - Tools: PICK charts.	
UNIT V	9 Hours
CONTROL STAGE AND DESIGN FOR LEAN SIX SIGMA	
Objectives of Control - Standardization of new methods - Measuring impact - Tools: control charts, charts for variables, charts for attributes. Design for lean six sigma: Quality Function Deployment, Failure Mode Effect Analysis, Design of experiments.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Dennis P Hobbs, Lean manufacturing implementation, J.Ross publication, 20042. Jay Arthur, Lean six sigma Demystified, Tata McGraw-Hill publication, New Delhi, 20073. Paul Keller, Six sigma Demystified, Tata McGraw-Hill publication, New Delhi, 20054. Mike George, Dave Rowlands, Bill Kastle, What is Lean Six Sigma?, Tata McGraw-Hill publication, New Delhi, 20045. Tapan P. Bagchi, Six Sigma, NPTEL Course, link : https://nptel.ac.in/courses/110105039/	

18ME0YM HEATING VENTILATION AND AIRCONDITIONING**3 0 0 3****Course Objectives**

- To provide knowledge on heat transfer, heating and cooling load
- To learn the different methods of ventilation and its rates
- To study methods of air Distribution, diffusion and applications of ventilation
- To impart knowledge on Psychometric processes and its applications
- To provide knowledge on different components and parameters involved in designing of 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.

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

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

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

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

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

Course Outcomes (COs)

1. Apply the principles of air conditioning to classify and compare systems such as window, split, VRV, and central air conditioning systems.
2. Assess the environmental factors, thermal exposure, and internal, external heat sources, students are expected to estimate the heat loads in buildings.
3. Implement appropriate duct design methods and select suitable fans based on system specifications, airflow requirements, and energy efficiency considerations.
4. Illustrate pump working principle and calculate water velocity to optimize flow efficiency in chilled and hot water distribution systems.
5. Design air distribution, chilled water systems, and select appropriate HVAC equipment and components for efficient system layout and installation.

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

UNIT I	9 Hours
INTRODUCTION TO HEAT TRANSFER, HEATING AND COOLING LOAD	
Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor. Cooling Load Estimation - Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, and equipments - Ventilation, air quantity, and loads - Load estimation methods. Heating load estimation - Vapour transfer in wall, vapour barrier, load estimation basics	
UNIT II	8 Hours
VENTILATION	
Ventilation - Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow around buildings. Methods of Ventilation - Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation	
UNIT III	8 Hours
AIR DISTRIBUTION, DIFFUSION AND VENTILATION APPLICATION	
Air Distribution - Ducts, types, fittings, air flow, friction chart, methods of sizing, Balancing. Air Diffusion - Isothermal jet, throw, drop, types of outlets, ADPI, outlet/inlet selection, Ventilation System Design - Exhaust ducts, filters, blowers, hoods, chimney. Industrial Ventilation - Steel plants, car parks, plant rooms, mines.	
UNIT IV	10 Hours
HUMAN COMFORT AND PSYCHROMETRIC PROCESS	
Human Comfort - Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. Psychrometric - Evolution of air properties and psychrometric chart - Basic Psychrometric processes - Bypass factor and Sensible heat ratio.	
UNIT V	10 Hours
AIR CONDITIONING	
AC Equipments - Filters, types, efficiency - Fans-basic equations, parallel and series configurations - Air washer, adiabatic, heated and cooled - Cooling tower, enthalpy potential, types, tower efficiency, NTU and characteristics, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance. Summer and Winter AC - Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.	
Total: 45 Hours	
Reference(s)	
<ol style="list-style-type: none">1. Auto Heating and Air Conditioning - Chris Johanson. Goodheart - Willcox Company, Inc. ISBN 978-1-61960-763-7; 4th edition.2. Haines, W.R. and Wilson, C.L., HVAC Systems Design Handbook, McGraw Hill, 2nd Ed., New Delhi, 1994.3. Legg, R.C., Air Conditioning Systems - Design, Commissioning and maintenance, Batsford Ltd, London 1991.4. ASHRAE Handbook - HVAC Systems and Equipments, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, USA, 2008.5. McQuiston, F.C., Parker, J.D. and Spitler, J.D. Heating, Ventilating and Air Conditioning, John Wiley & Sons Inc., 2001.	