NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai & Accredited by NAAC)

K.R. NAGAR, KOVILPATTI – 628 503
www.nec.edu.in

REGULATIONS – 2019

CURRICULUM & SYLLABUS

B. E. – MECHANICAL ENGINEERING
Accredited by NBA

B.E. – MECHANICAL ENGINEERING

CURRICULUM AND SYLLABUS

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

Producing globally competitive Mechanical Engineers with social responsibilities.

MISSION

- Imparting quality education by providing excellent Teaching-learning environment.
- Inculcating qualities of continuous learning, professionalism, team spirit, communication skill and leadership with social responsibilities.
- Promoting leading edge research and development through collaboration with academia and industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Programme educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

After 3 to 5 years of completion of our graduation our,

PEO1: Graduates will have successful profession in Mechanical/Allied Industries or Research/Academics or Business Enterprise.

PEO2: Graduates will be able to broaden their horizons beyond Mechanical Engineering to address the societal and environmental concerns.

PEO3: Graduates will have the attitudes and abilities of leaders to adapt the changing global scenario.

PROGRAMMESPECIFIC OUTCOMES (PSOs)

After successful completion of B.E. Mechanical Engineering Programme, the students should be able to

PSO1: Apply the concepts of Engineering Design to design, analyze and develop the mechanical components and systems using the different analytical/CAD/experimental tools.

PSO2: Apply the concepts of Thermal Engineering to design, analyze and develop the flow and energy systems using the different analytical/experimental/software tools.

PSO3: Apply the concepts of Production, Industrial Engineering and Management for analysis, optimization and development of mechanical systems.

PROGRAMME OUTCOMES (POs)

After the successful completion of Mechanical Engineering Program, the graduates will be able to,

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

PO2: Identify, formulate, research literature, and analyze complex problems in Mechanical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design solutions for complex Mechanical Engineering problems and design system 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 for complex Mechanical Engineering Problems.

PO5: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Mechanical 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.

PREAMBLE OF THE CURRICULUM & SYLLABI

The Curriculum and Syllabi under Regulations 2019 are implemented based on the recommendations of AICTE, New Delhi and UGC, New Delhi. The course content of each course shall be fixed in accordance with the Programme Educational Objectives (PEOs), Programme Outcomes (POs) and Course Outcomes (COs).

Further, The CBCS enables the students to earn credits across programmes and provides flexibility for slow and fast learners in registering the required number of credits in a semester. The CBCS facilitates the transfer of credits earned in different departments / Centers of other recognized / accredited universities or institutions of higher education in India and abroad either by studying directly or by online method.

The curriculum of **Mechanical Engineering programme** is designed with total number of credits ***166 (125*** for Lateral entry). The curriculum shall have the following category of courses with credits as given in Table - I.

Table – 1 CATEGORY OF COURSES

Sl. No	Coursework – Subject Area	The range of Total credits
1.	Humanities and Social Sciences including Management courses	07
2.	Basic Science courses	23
3.	Engineering Science courses	32
4.	Professional Core courses	52
5.	Professional Elective courses relevant to chosen specialization / branch	18
6.	Open Elective courses from other technical and /or emerging subject areas	18
7.	Skill Development Courses	16
8.	Mandatory courses	(Non – credit)
	TOTAL	**166**

i. **Humanities and Social Sciences(HSMC)**include English, Communication Skill laboratory and Management courses

ii. **Basic ScienceCourses**(**BSC)** include Chemistry, Physics, Biology and Mathematics

iii. **Engineering Science Courses(ESC)**include Workshop, Drawing, Basics of Electrical / Electronics / Mechanical / Civil / Computer / Instrumentation Engineering

iv. **Professional Core Courses (PCC)** include the core courses relevant to the chosen programme of study.

v. **Professional Elective Courses (PEC)** include the elective courses relevant to the chosen programme of study.

vi. **Open Elective Courses (OEC)** include inter-disciplinary courses which are offered in other Engineering/Technology Programme of study.

vii. **Skill Development Courses (SDC)** includethe courses such as Project, Seminar and Inplant training / Internship for improving Employability Skills.

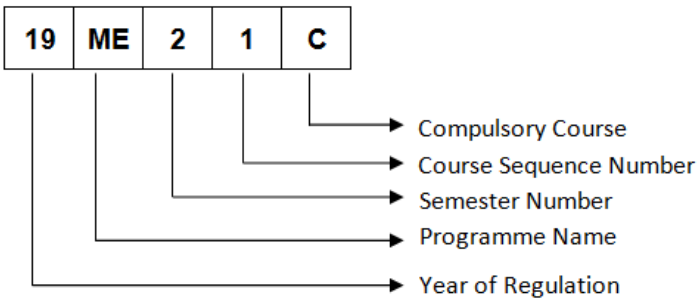
viii. **Mandatory courses (MAC)** include Personality and Character development and the courses recommended by the regulatory bodies such as AICTE, UGC, etc.

Performance in each course of study shall be evaluated based on Continuous Assessment throughout the semester and end semester examination at the end of the programme. Keeping in mind the content of the courses and delivery methods, different question paper patterns are suggested, as given in Table-2.

TABLE – 2 QP - QUESTION PATTERN

Subject Type	Question pattern	2 marks	4 marks	10 marks	11 marks	12 marks	20 marks	Total
Theory (3/4 Credit)	A	10	5	--	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
Theory (2 Credit)	B	10	-	-	1 Qn Compulsory & 4Qn (either or type)			75
Theory (1 Credit)	C	5	--	1 Qn Compulsory & 1 Qn (either or type)	--	--	--	30
Theory Trans Disciplinary	D	--	--	--	--	--	5 out of 8	100
Design oriented	E	--	--	--	--	--	1 Qn Compulsory & 4 Qns (either or type)	100
10,11 and 12 marks questions will be a single question and no subdivisions								

FORMAT FOR COURSE CODE



REGULATIONS – 2019 CURRICULUM AND SYLLABUS

SEMESTER – I

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	HSMC	19SH11C	Technical English	2	0	0	2	B
2.	BSC	19SH12C	Mathematical Foundations For Engineers	3	1	0	4	A
3.	BSC	19SH13C	Engineering Physics	2	0	0	2	B
4.	BSC	19SH14C	Engineering Chemistry	2	0	0	2	B
5.	ESC	19SH15C	Engineering Graphics	2	0	4	4	E
PRACTICAL COURSES								
6.	BSC	19SH16C	Engineering Physics and Engineering Chemistry Laboratory Part A – Engineering Physics Laboratory Part B – Engineering Chemistry Laboratory	0	0	3	1.5	-
7.	ESC	19SH17C	Engineering Practice Laboratory Part A – Mechanical Laboratory Part B – Electrical and Electronics Laboratory	0	0	4	2	-
			TOTAL	**11**	**1**	**11**	**17.5**	

SEMESTER – II

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1	HSMC	19ME21C	Professional English	2	0	0	2	B
2	BSC	19ME22C	Applied Mathematics	3	1	0	4	A
3	BSC	19ME23C	Physics of materials	2	0	0	2	B
4	BSC	19ME24C	Chemistry for Mechanical Engineering	2	0	0	2	B
5	ESC	19ME25C	Engineering Mechanics	3	1	0	4	A
6	ESC	19ME26C	Basic Electrical and Electronics Engineering	3	0	0	3	A
PRACTICAL COURSES								
7.	BSC	19ME27C	Physics and Chemistry Laboratory Part A – Physics Laboratory Part B – Chemistry Laboratory	0	0	3	1.5	-
8.	ESC	19ME28C	Basic Electrical and Electronics Engineering Laboratory	0	0	3	1.5	-
9	ESC	19ME29C	Drafting and Modeling Laboratory	0	0	3	1.5	-
10.	SDC	19GN01C	Innovation through Design Thinking	1	0	2	2	-
			TOTAL	**16**	**2**	**11**	**23.5**	

SEMESTER – III

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	BSC	19ME31C	Probability, Statistics and Numerical Methods	3	1	0	4	A
2.	ESC	19ME32C	Computer Programming	3	0	0	3	A
3.	ESC	19ME33C	Thermodynamics	3	1	0	4	A
4.	PCC	19ME34C	Manufacturing Technology-I	2	0	2	3	A
5.	PCC	19ME35C	Kinematics of Machinery	3	1	0	4	A
6.	OEC	E1	Open Elective (Group – I)	3	0	0	3	A
7.	MAC	19MC02C	Constitution of India	3	0	0	0	D
PRACTICAL COURSES								
8.	ESC	19ME36C	Computer Programming Laboratory	0	0	2	1	-
9.	HSMC	19ME37C	Communication Skills Laboratory	0	0	2	1	-
			TOTAL	**20**	**3**	**6**	**23**	

SEMESTER – IV

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	ESC	19ME41C	Fluid Mechanics and Machinery	3	1	0	4	A
2.	PCC	19ME42C	Strength of Materials	3	1	0	4	A
3.	PCC	19ME43C	Thermal Engineering	3	1	0	4	A
4.	PCC	19ME44C	Manufacturing Technology-II	2	0	0	2	B
5.	ESC	19ME45C	Materials Science and Metallurgy	3	0	0	3	A
6.	MAC	19MC03C	Safety, Health and Environmental Engineering	3	0	0	0	D
PRACTICAL COURSES								
7.	ESC	19ME46C	Fluid Mechanics and MachineryLaboratory	0	0	2	1	-
8.	PCC	19ME47C	Thermal Engineering Laboratory	0	0	2	1	-
9.	PCC	19ME48C	Material Testing Laboratory	0	0	2	1	-
10.	PCC	19ME49C	Manufacturing Technology Laboratory	0	0	2	1	-
			TOTAL	**17**	**3**	**8**	**21**	

SEMESTER – V

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	19ME51C	Heat and Mass Transfer	3	1	2	5	A
2.	PCC	19ME52C	Dynamics of Machinery	3	1	0	4	A
3.	PCC	19ME53C	Design of Machine Elements	3	1	0	4	A
4.	PCC	19ME54C	Automation in Manufacturing	3	0	0	3	A
5.	HSMC	19ME55C	Professional Ethics	1	0	0	1	C
6.	OEC	E2	Open Elective (Group – II)	3	0	0	3	-
PRACTICAL COURSES								
7.	PCC	19ME56C	Dynamics Laboratory	0	0	2	1	**-**
8.	PCC	19ME57C	Computer Aided Design and Manufacturing Laboratory	0	0	2	1	**-**
			TOTAL	**16**	**3**	**6**	**22**	

SEMESTER – VI

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	19ME61C	Metrology and Measurements	3	0	0	3	A
2.	PCC	19ME62C	Design of Transmission Systems	2	1	0	3	E
3.	PCC	19ME63C	Finite Element Analysis	2	1	0	3	A
4.	HSMC	19ME64C	Project Management	1	0	0	1	C
5.	OEC	E3	Open Elective (Group – III)	2	0	2	3	-
6.	PEC	E4	Elective-I	3	0	0	3	-
7.	PCC	19ME65C	Comprehension	0	0	2	1	-
PRACTICAL COURSES								
8.	PCC	19ME66C	Metrology and Automation Laboratory	0	0	2	1	**-**
9.	PCC	19ME67C	Computer Aided Analysis Laboratory	0	0	2	1	**-**
10.	SDC	19ME68C	Product Development Laboratory	1	0	2	2	**-**
			TOTAL	**14**	**2**	**10**	**21**	

SEMESTER – VII

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	PCC	19ME71C	Industrial Engineering	2	0	0	2	B
2.	OEC	E5	Open Elective (Group – IV)	3	0	0	3	-
3.	OEC	E6	Open Elective (Group – V)	3	0	0	3	-
4.	PEC	E7	Elective-II	3	0	0	3	-
5.	PEC	E8	Elective-III	3	0	0	3	-
6.	PEC	E9	Elective-IV	3	0	0	3	-
PRACTICAL COURSES								
7.	SDC	19ME72C	Project Phase-I	0	0	6	3	**-**
9.	SDC	19ME73C	Research Paper and Patent Review-Seminar	0	0	2	1	**-**
10.	SDC	19ME74C	Internship / In-plant Training	0	0	4	2	**-**
			TOTAL	**17**	**-**	**12**	**23**	

SEMESTER – VIII

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY COURSES								
1.	OEC	E10	Open Elective (Group – VI)	3	0	0	3	-
2.	OEC	E11	Elective-V	3	0	0	3	-
3.	OEC	E12	Elective-VI	3	0	0	3	-
PRACTICAL COURSE								
4.	SDC	19ME81C	Project Phase-II	0	0	12	6	**-**
			TOTAL	**9**	**-**	**12**	**15**	

TOTAL CREDITS - 166

PROGRAMME ELECTIVE COURSES (PEC)

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THERMAL MODULE								
1.	PEC	19ME01E	Refrigeration and Air Conditioning	3	0	0	3	A
2.	PEC	19ME02E	Design of Heat Exchanger and Pressure Vessel	2	0	2	3	E
3.	PEC	19ME03E	Automobile Engineering	3	0	0	3	A
4.	PEC	19ME04E	Internal Combustion Engines	3	0	0	3	A
5.	PEC	19ME05E	Gas Dynamics and Propulsion Systems	3	0	0	3	A
6.	PEC	19ME06E	Power Plant Engineering	3	0	0	3	A
7.	PEC	19ME07E	Renewable Energy Sources	3	0	0	3	A
8.	PEC	19ME08E	Solar Photovoltaic Energy Conversion	3	0	0	3	A
9.	PEC	19ME09E	Thermal Design and Management of Electronic Equipments	3	0	0	3	A
10.	PEC	19ME10E	Energy Conservation and Waste Heat Recovery	3	0	0	3	A
11.	PEC	19ME11E	Heating Ventilation and Air Conditioning Systems	3	0	0	3	A
12.	PEC	19ME12E	Turbomachines	3	0	0	3	A
13.	PEC	19ME13E	Automotive Electronics	3	0	0	3	A
14.	PEC	19ME14E	Energy Storage Systems	3	0	0	3	A
15.	PEC	19ME15E	Computational Fluid Dynamics	2	0	2	3	E
16.	PEC	19ME16E	Hybrid Electric Vehicles	3	0	0	3	A
DESIGN MODULE								
17.	PEC	19ME17E	Hydraulics and Pneumatics	3	0	0	3	A
18.	PEC	19ME18E	Design of Jigs, Fixtures and Press Tools	3	0	0	3	E
19.	PEC	19ME19E	Mechatronics	3	0	0	3	A
20.	PEC	19ME20E	Industrial Robotics	3	0	0	3	A
21.	PEC	19ME21E	Advanced Modeling Techniques	2	0	2	3	E
22.	PEC	19ME22E	Piping Design Engineering	2	0	2	3	E
23.	PEC	19ME23E	Vibration Control	3	0	0	3	A
24.	PEC	19ME24E	Vehicle Systems Design	3	0	0	3	A
25.	PEC	19ME25E	Industrial Tribology	2	0	2	3	A
26.	PEC	19ME26E	New Product Development	2	0	2	3	A
27.	PEC	19ME27E	Design for Manufacture, Assembly and Environments	3	0	0	3	A
28.	PEC	19ME28E	MEMS Devices – Design and Fabrication	3	0	0	3	A
MANUFACTURING MODULE								

29.	PEC	19ME29E	Applied Nano Technology	3	0	0	3	A
30.	PEC	19ME30E	Composite Materials	3	0	0	3	A
31.	PEC	19ME31E	Unconventional Machining Processes	3	0	0	3	A
32.	PEC	19ME32E	Additive Manufacturing	3	0	0	3	A
33.	PEC	19ME33E	Welding Technology	3	0	0	3	A
34.	PEC	19ME34E	Maintenance Engineering	3	0	0	3	A
35.	PEC	19ME35E	Non-Destructive Evaluation	2	0	2	3	E
36.	PEC	19ME36E	Quality Control of Welded Structures	3	0	0	3	A
37.	PEC	19ME37E	Machine Tool Control	3	0	0	3	A
38.	PEC	19ME38E	Computer Integrated Manufacturing	3	0	0	3	A
INDUSTRIAL ENGINEERING MODULE								
39.	PEC	19ME39E	Total Quality Management	3	0	0	3	A
40.	PEC	19ME40E	Operations Research	3	0	0	3	E
41.	PEC	19ME41E	Implementation of Quality Management System	3	0	0	3	A
42.	PEC	19ME42E	Production and Operations Management	3	0	0	3	A
43.	PEC	19ME43E	Value Analysis and Value Engineering	3	0	0	3	A
44.	PEC	19ME44E	Supply Chain and Logistic Management	3	0	0	3	A
45.	PEC	19ME45E	Statistical Quality Control	3	0	0	3	A
46.	PEC	19ME46E	Process Planning and Cost Estimation	3	0	0	3	A
47.	PEC	19ME47E	Lean Manufacturing	3	0	0	3	A
48.	PEC	19ME48E	Industrial Safety Engineering	3	0	0	3	A
49.	PEC	19ME49E	Production Planning and Control	3	0	0	3	A
50.	PEC	19ME50E	Engineering Economics and Cost Analysis	3	0	0	3	A
51.	PEC	19ME51E	Ecommerce	3	0	0	3	A
52.	PEC	19ME52E	Industry 4.0	3	0	0	3	A

ONE CREDIT ELECTIVE COURSES (PEC)

S. No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern$^{\oplus}$
THERMAL MODULE								
1.	PEC	19ME01L	Shell and Tube Heat Exchanger Design	1	0	0	1	C
2.	PEC	19ME02L	Energy Audit and Management	1	0	0	1	C
3.	PEC	19ME03L	Pyrolysis and Gasification	1	0	0	1	C
4.	PEC	19ME04L	Grid Tied PV System Design	1	0	0	1	C
5.	PEC	19ME05L	Micro Grid	1	0	0	1	C

6.	PEC	19ME06L	Thermal Energy Storage Systems	1	0	0	1	C
7.	PEC	19ME07L	Solar Cooling Systems	1	0	0	1	C
8.	PEC	19ME08L	Desalination	1	0	0	1	C
9.	PEC	19ME09L	Thermal Characterization of Materials	1	0	0	1	C
10.	PEC	19ME10L	Thermal Analysis of Mechanical Systems Using FEM	1	0	0	1	C
DESIGN MODULE								
11.	PEC	19ME11L	Industrial Drawing Reading with Geometric Dimensioning and Tolerancing	1	0	0	1	C
12.	PEC	19ME12L	Fundamentals of Process Equipment	1	0	0	1	C
13.	PEC	19ME13L	Techniques for Vibration Monitoring and Controls	1	0	0	1	C
14.	PEC	19ME14L	Crashworthiness of Tubular Shells	1	0	0	1	C
15.	PEC	19ME15L	Failure Mode and Effects Analysis	1	0	0	1	C
16.	PEC	19ME16L	Design of Experiments	1	0	0	1	C
17.	PEC	19ME17L	Taguchi Methods	1	0	0	1	C
18.	PEC	19ME18L	Creative and Innovative Methods for Design and Development	1	0	0	1	C
19.	PEC	19ME19L	Creep and Fatigue	1	0	0	1	C
MANUFACTURING MODULE								
20.	PEC	19ME20L	Natural Fiber Composites	1	0	0	1	C
21.	PEC	19ME21L	Functional Materials for Energy Conversion	1	0	0	1	C
22.	PEC	19ME22L	Design for Manufacturability	1	0	0	1	C
23.	PEC	19ME23L	Six Sigma	1	0	0	1	C
24.	PEC	19ME24L	Agile Manufacturing	1	0	0	1	C
25.	PEC	19ME25L	Surface Engineering	1	0	0	1	C
INDUSTRIAL ENGINEERING MODULE								
26.	PEC	19ME26L	Optimization in Scheduling	1	0	0	1	C
27.	PEC	19ME27L	Design a Startup	1	0	0	1	C
ARTIFICIAL INTELLIGENCE								
28.	PEC	19ME28L	Predictive Maintenance	1	0	0	1	C
29.	PEC	19ME29L	Intelligent Manufacturing	1	0	0	1	C
30.	PEC	19ME30L	Artificial Intelligence in Production Management	1	0	0	1	C

Open Elective Course (OEC)

Group – I (Basic science courses)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19ME01N	Applied Chemistry	3	0	0	3	A
2.	OEC	19ME02N	Biophysics	3	0	0	3	A
3.	OEC	19ME03N	Calculus and Statistics for Engineers	3	0	0	3	A
4.	OEC	19ME04N	Corrosion Science and Engineering	3	0	0	3	A
5.	OEC	19ME05N	Polymer science and Technology	3	0	0	3	A
6.	OEC	19ME06N	Laser Technology	3	0	0	3	A
7.	OEC	19ME07N	Fundamentals of Nano Science	3	0	0	3	A
8.	OEC	19ME08N	Biology for Mechanical Engineers	3	0	0	3	A
9.	OEC	19ME09N	Introduction to Robotics	3	1	0	4	A

Group – II (Engineering science courses of other discipline)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19ME11N	Testing and Calibration of Instruments	3	0	0	3	A
2.	OEC	19ME12N	Digital Electronics for Engineers	3	0	0	3	A
3.	OEC	19ME13N	Instrumentation and Control	3	0	0	3	A
4.	OEC	19ME14N	Microprocessor, Microcontroller and Applications	3	0	0	3	A
5.	OEC	19ME15N	Electrical Drives and Control	3	0	0	3	A
6.	OEC	19ME16N	Foundations of Machine Learning	2	0	2	3	A
7.	OEC	19ME17N	Mechanics of Robots	3	0	0	3	A

Group – III(Computational Skills)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19ME21N	Computer Graphics and Virtual Reality	2	0	2	3	A
2.	OEC	19ME22N	Mobile Application Development	2	0	2	3	A
3.	OEC	19ME23N	Object Oriented Programming	2	0	2	3	A
4.	OEC	19ME24N	Programming in Python	2	0	2	3	A

5.	OEC	19ME25N	Fundamentals of Java Programming	2	0	2	3	A
6.	OEC	19ME26N	Programming for Robotics	2	0	2	3	A
7.	OEC	19ME27N	Fundamentals of Artificial Intelligence	2	0	2	3	A
8.	OEC	19ME28N	Modelling and Simulation	2	0	2	3	A
9.	OEC	19ME29N	Essentials of Machine Learning	2	0	2	3	A
10.	OEC	19ME30N	Microprocessor & Embedded Systems	3	0	2	4	A

Group – IV (Management Skills)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19ME31N	Entrepreneurship	3	0	0	3	A
2.	OEC	19ME32N	Human Resource Management	3	0	0	3	A
3.	OEC	19ME33N	Industrial Psychology and Organizational Behavior	3	0	0	3	A
4.	OEC	19ME34N	Principles of Management	3	0	0	3	A
5.	OEC	19ME35N	Business Statistics	3	0	0	3	A
6.	OEC	19ME36N	Financial Management	3	0	0	3	A
7.	OEC	19ME37N	Accounting for Engineers	3	0	0	3	A
8.	OEC	19ME38N	Security Analysis and Portfolio Management	3	0	0	3	A

Group – V (Core/Elective courses of other discipline)

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19ID01E	Product Design and Development	3	0	0	3	A
2.	OEC	19ID02E	Disaster Management	3	0	0	3	A
3.	OEC	19ID03E	Energy Engineering	3	0	0	3	A
4.	OEC	19ID04E	Control of Robotic Systems	3	0	0	3	A
5.	OEC	19ID05E	Product Lifecycle Management	3	0	0	3	A
5.	OEC	-	Other Programme Courses	3	0	0	3	As specified for the chosen course

Group-VI(Trans-disciplinary courses) - Self Study Course

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
Any one of the following courses is compulsory								
1.	OEC	19TD01E	Soft Skills and Interpersonal Communication	0	0	0	3	D
2.	OEC	19TD02E	ICT for Development	0	0	0	3	D
3.	OEC	19TD03E	Human Resource Development and Organizational Behavior	0	0	0	3	D
4.	OEC	19TD04E	Cyber Law and Ethics	0	0	0	3	D
5.	OEC	19TD05E	Introduction to Philosophical Thoughts	0	0	0	3	D
6.	OEC	19TD06E	Comparative Study of Literature	0	0	0	3	D
7.	OEC	19TD07E	Indian Music System	0	0	0	3	D
8.	OEC	19TD08E	History of Science & Engineering	0	0	0	3	D
9.	OEC	19TD09E	Introduction to Art and Aesthetics	0	0	0	3	D
10.	OEC	19TD10E	Economic Policies in India	0	0	0	3	D
11.	OEC	19TD11E	Metro Systems and Engineering	0	0	0	3	D

19SH11C **TECHNICAL ENGLISH** **L T P C**
(Common to all B.E. / B.Tech. Degree Programmes) **2 0 0 2**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1:apply the basic language skills to understand various aspects of communication skills (K3)

CO2: express their thoughts with correct usage of language in formal writings (K3)

CO3: understand various language components and develop the pronunciation skill. (K2)

CO4: make effective technical writings and interpret any pictorial representation. (K3)

CO5: frame sentences and write effective reports. (K3)

UNIT I **6**

Parts of Speech – Word formation using Prefixes and Suffixes - Informal writing - Diary writing, Letter to Friend / Parent / Siblings - Greetings and Self Introduction –Situational Phrases - Tense (Present)

UNIT II **6**

Technical terms and extended definitions - Transformation of words into different grammatical forms – Tense (Past) –Letter writing (for Industrial visit and training) - Instruction Writing - Listening for general information.

UNIT III **6**

Personality Adjectives - Phonetics (Vowels - Consonants– Diphthongs - Transcriptions) – Kinds of Sentences (Statement, Interrogative, Imperative & Exclamatory) – Situational Conversation.

UNIT IV **6**

Commonly Misspelled words – Active and Passive Voices – E - mail writing - Picture Description – Checklists

UNIT V **6**

Homophones - Concord - Tense (Future) - Foreign Words and Phrases - Report writing (Types – Structure - Stages in Report writing- Model Report) – Reading Comprehension.

Suggested Activity: Book Review – Herein the students will be required to submit a review of a book (Literary or non-literary) of their choice. This will be followed by a presentation of the same in the class.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Anderson, Paul V. “Technical Communication: A Reader - Centered Approach”, 9th Edition, Cengage, New Delhi, 2018.
2. Jan Svartvik, et.al. “A Comprehensive Grammar of the English Language”, Longman Inc., Newyork, 2014.

REFERENCES

1. Murphy Raymond, "Basic Grammar Practice on Tense", Cambridge University Press: New Delhi, 2018.
2. Kumar, Suresh. E., "Engineering English", Orient Blackswan: Hyderabad, 2015.

19SH12C MATHEMATICAL FOUNDATIONS FOR ENGINEERS L T P C
(Common to all B.E. / B.Tech. Degree Programmes) 3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: make use of orthogonal transformation. (K3)
CO2: find the evolutes of various curves. (K2)
CO3: maxima and minima of real valued functions. (K3)
CO4: solve ordinary differential equations. (K2)
CO5: solve partial differential equations. (K2)

UNIT I MATRICES 12

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors – Diagonalisation of a matrix by orthogonal transformation – Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation and its nature; Cayley – Hamilton theorem (excluding proof)

UNIT II DIFFERENTIAL CALCULUS 12

Curvature in cartesian, parametric and polar forms – Centre of curvature, radius of curvature and circle of curvature – Evolutes – Envelopes – Evolute as envelope of normals.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivative – Total derivative – Euler's theorem on homogeneous functions – Taylor's Series – Jacobians – Maxima and Minima – Constrained Maxima and Minima by the method of Lagrange's multipliers.

UNIT IV ORDINARY DIFFERENTIAL EQUATIONS 12

Solutions of first order ordinary differential equations - Equations solvable for 'p', equations solvable for 'y', equations solvable for 'x' - Solutions of higher order linear differential equations with constant coefficients – Cauchy's and Legendre's linear equations - Method of variation of parameters – Solution of simultaneous linear differential equation.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - Lagrange's linear equations - Solutions of homogeneous and Non homogeneous linear partial differential equations of second and higher order with constant coefficients.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publications, New Delhi, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2014.

REFERENCES

1. Bali.N.P. and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Laxmi Publications Private Limited, 2017.
2. George B.Thomas, Jr. Ross L.Finney, "Calculus and Analytic Geometry", 9th Edition, Dorling Kindersley Private Limited, 2010.

19SH13C ENGINEERING PHYSICS L T P C

(Common to all B.E. / B.Tech. Degree Programmes) 2 0 0 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: summarize the properties and structures of crystal solids. (K2)

CO2: understand the principle and propagation of different types of waves (K2)

CO3: choose the appropriate Laser technique for industrial and medical applications (K2)

CO4: describe the different types, fabrication, losses of optical fibers and their applications in communication and instrumentation. (K2)

CO5: explain the physical properties of photons & electrons and their applications in different electron microscopes. (K2)

UNIT I CRYSTALLOGRAPHY 6

Lattice, Unit cell, Bravais lattice, Lattice planes-Crystal system-Miller indices – d spacing - Characteristics of SC, BCC, FCC and HCP structures- Crystal defects.

UNIT II WAVES 6

Simple harmonic oscillators - Damped harmonic oscillator-Forced mechanical and electrical oscillators - Transverse wave on a string - Wave equation on a string - Longitudinal waves and wave equation - Acoustics waves

UNIT III LASER 6

Principle of spontaneous emission and stimulated emission, Population inversion, Pumping, Einstein's A and B coefficients – Different types of lasers: gas lasers (CO_2), solid-state lasers (Nd-YAG) - Applications of lasers in science, engineering and medicine.

UNIT IV FIBRE OPTICS 6

Principle – Total internal reflection - Acceptance angle and Numerical aperture - Types of optical fibers - Double crucible technique – Splicing - Losses in optical fibers - Fiber optic communication system - Applications - Fiber optic sensors – Medical Endoscope.

UNIT V QUANTUM PHYSICS 6

Black Body Radiation - Matter Waves - Heisenberg's uncertainty principle - Schrodinger's wave equation - Particle in one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. David Halliday, Robert Resnick, Jearl Walker, "Fundamentals of Physics", 11th Edition, John Wiley & Sons Inc.USA, 2018.
2. Arthur Beiser, "Concepts of Modern Physics", 7th Edition, Mc-Graw Hill Publications Private Limited, 2017.
3. D. J. Griffiths, "Quantum mechanics", 2nd Edition, Cambridge University Press, 2014.

REFERENCES

1. Renk, Karl.F "Basics of laser physics", 2ndEdition, Springer international publishing, 2017.
2. H. J. Pain,Patricia Rankin "Introduction to vibration and waves", 1st Edition, Wiley, 2015
3. K.S.Mathur, "Fundamentals of Fiber Optics", 1st Edition, Zorba books, 2018.

19SH14C ENGINEERING CHEMISTRY L T P C

(Common to all B.E. / B.Tech. Degree Programmes) 2 0 0 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: identify the various water treatment technique for domestic and industrial purpose. (K2)

CO2: understand the various isotherms, kinetics in surface chemistry and catalysis. (K2)

CO3: acquire the knowledge of electrochemistry and corrosion and its control. (K2)

CO4: familiar with the various novel organic material used in electronics industry. (K2)

CO5: understand the principle, components and working of various analytical instruments.(K2)

UNIT I WATER TREATMENT 6

Hardness - Estimation of hardness of water –Specifications for drinking water (BIS and WHO standards) - Softening of water: External and Internal treatments of water – Desalination - Methods of treatment of municipal water - Waste water treatments: primary, secondary and tertiary

UNIT II SURFACE CHEMISTRY AND CATALYSIS 6

Adsorption – Types - Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – Kinetics of surface reactions-Unimolecular reactions - Applications of adsorption on pollution abatement.

Catalysis: Catalyst – Types of catalysis – Criteria – Autocatalysis – Acid base catalysis – applications -Catalytic convertor – Enzyme catalysis – Michaelis – Menten equation.

UNIT III ELECTROCHEMISTRY AND CORROSION 6

Electrode potential-Nernst Equation-reference electrode- glass electrode - measurement of pH –electrochemical series –significance – Conductometric titrations (strong acid vs strong base and weak acid vs strong base)

Corrosion: Types of corrosion - Factors influencing corrosion –Corrosion control – Sacrificial anode and impressed current cathodic methods – Corrosion inhibitors

UNIT IV ELECTRONIC MATERIALS 6

Organic semiconducting materials: advantages- p-type and n-type semiconducting materials –pentacene – fullerens-C-60; organic light emitting polymer: polyvinylidenefluoride- OLED material – polyphenylene vinylene - micro and nano sensors - fundamentals of sensors, biosensor - chemical sensors

UNIT V ANALYTICAL TECHNIQUES 6

Spectroscopy:Principle, instrumentation and applications of UV-Visible and IR spectroscopy. chromatography: - HPLC (Principle, instrumentation and applications of HPLC and gas chromatography - Flame photometry – Estimation of sodium and potassium by Flame photometry.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Jain P.C. and Jain. M., “Engineering Chemistry”, Dhanpat Rai Publishing Company, 16th Edition, New Delhi, 2016.
2. S.S Dara and S.S Umare, A Text Book of Engineering Chemistry, S.Chand& Company Limited, 20th Edition, 2018.

REFERENCES

1. P. Brezonik, W. Arnold, Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Aquatic Systems, Oxford Press, 6th Edition, 2017.
2. B.R. Puri, L.R. Sharma, M.S. Pathania,Vishal, Principles of Physical Chemistry,Vishal Publishing Co., Punjab, 47th Edition, 2017.
3. S. Crouch, D. Skoog, F Holler, Principles of Instrumental Analysis Hardcover, 2017.
4. H. Klauk, “Organic Electronics: Materials, manufacturing and applications”, Wiley - VCH, 2016

19SH15C ENGINEERING GRAPHICS L T P C

(Common to all B.E. / B.Tech. Degree Programmes) 2 0 4 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: familiarize with the fundamentals of Engineering graphics and construct the engineering curves. (K2)

CO2: construct the orthographic projections of points, straight lines and lamina (K2)

CO3: draw the projections of simple solids in different positions. (K3)

CO4: visualize the sectional views and surface areas of various solids. (K3)

CO5: perform freehand sketching and prepare elementary 2-D and 3D sketches of simple solids. (K3)

INTRODUCTION **5**

Principles of Engineering Graphics – significance. Usage of Drawing Instruments. Lettering and dimensioning exercise. First angle projection should be followed for all the topics except projection of points.

UNIT I ENGINEERING CURVES **17**

Construction of ellipse, parabola and hyperbola using eccentricity method– Construction of cycloids, Epi and Hypo-cycloids - construction of involutes for square and circle –Tangent and Normal to the above curves.

UNIT II ORTHOGRAPHIC PROJECTIONS **17**

Principle of orthographic projections – Conventions - First angle and third angle projections. Projections of points placed in all quadrants – projections of straight lines – inclined to both reference planes - determination of true length and inclinations. Projections of regular polygonal surfaces and circular lamina inclined to both reference planes.

UNIT III PROJECTIONS OF SOLIDS **17**

Projections of simple solids like prisms, pyramids, cylinder and cone - axis inclined to one reference plane - change of position method.

UNIT IV SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES **17**

Sectioning of simple solids – Axis perpendicular to horizontal plane- Drawing sectional views with true shape of the section.

Development of lateral surfaces of truncated solids – Prisms, pyramids, cylinder and cone.

UNIT V ISOMETRIC PROJECTIONS AND FREE HAND SKETCHING **17**

Principles of isometric projection – isometric scale – isometric projections of simple solids like prism, pyramid, cone and cylinder – Combination of solids.Orthographic views of simple components by Free hand drawing - Transferring measurement from the given object to the free hand sketches.

L: 30; P:60; TOTAL: 90 PERIODS

TEXT BOOKS

1. Bhatt N.D, “Engineering Drawing”, 53rd Edition, Charotar Publishing House, 2014.
2. Shah M.B and Rana B.C, “Engineering Drawing”, Pearson Education, 2nd Edition, 2009.

REFERENCES

1. Agrawal B. & Agrawal C.M., Engineering Graphics, TMH Publication, 2nd Edition, 2013
2. Narayana K.L. & Kannaiah P, Text book on Engineering Drawing, Scitech Publishers, 2010.
3. Gopalakrishna K.R, “Engineering Drawing”, Subhas Publications, 32nd Edition, 2017.

19SH16C **ENGINEERING PHYSICS AND ENGINEERING CHEMISTRY LABORATORY** **L T P C 0 0 3 1.5**

(Common to all B.E. / B.Tech. Degree Programmes)

PART A – ENGINEERING PHYSICS LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: demonstrate the different phenomenon exhibited by the waves. (K2)

CO2: interpret the production of ultrasounds and the variation of velocity of ultrasounds with respect to different medium.(K2)

CO3: illustrate the electrical properties of materials. (K2)

LIST OF EXPERIMENTS

1. Determination of thickness of a thin wire – Air wedge method.
2. Determination of velocity of sound and compressibility of the liquid – Ultrasonic Interferometer.
3. Determination of Dispersive power of a prism using Spectrometer.
4. Determination of angle of divergence of laser beam and acceptance angle, numerical aperture of optical fibre.
5. Determination of acceleration due to gravity using compound pendulum.
6. Determination of (a) spring Constant (b) Value of g and (c) Modulus of Rigidity of a spring by studying motion of a spring.
7. Determination of specific resistance of the coil using Carey-Foster's bridge.

- A minimum of FIVE experiments shall be offered.

REFERENCES

1. David Loyal, " Physics laboratory" 4thEdition, Cengage learning, 2013
2. Sesha Sai Kumar Vemula, "Engineering Physics lab manual" 1stEdition, LAP LAMBERT Academic Publishing, 2017

PART B - ENGINEERING CHEMISTRY LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: determine various water quality parameters. (K2)

CO 2: quantify different ions by different analytical techniques. (K2)

CO3: determine the rate of corrosion of mild steel plate. (K2)

CO4: verify the freundlich adsorption isotherm. (K2)

LIST OF EXPERIMENTS

1. Estimation of hardness of water sample by EDTA method.
2. Estimation of iron (Fe^{2+}) by dichrometric method.
3. Determination of rate of corrosion of mild steel plate by weight loss method.
4. Estimation of hydrochloric acid by conductometric method.
5. Estimation of mixture of acids by conductometric method.

6. Determination of purity of simple organic compounds using HPLC- (Demo).
7. Estimation of iron (Fe^{2+}) by spectrophotometric method.
8. Verification of Freundlich adsorption isotherm by using oxalic acid in activated charcoal.

P: 45; TOTAL: 45 PERIODS

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.

REFERENCES

1. D.C. Harris "Quantitative Chemical Analysis: International Edition", W.H.Freeman, 9th Edition, 2016.
2. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford ,P.W.G.Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson Education Limited, England, 8th Edition, 2015.
3. M. Nath, Inorganic Chemistry: A Laboratory Manual, Alpha Science, New Delhi, 2016.

19SH17C	**ENGINEERING PRACTICE LABORATORY**	**L T P C**
	(Common to all B.E. / B.Tech. Degree Programmes)	**0 0 4 2**

PARTA-MECHANICAL LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: prepare different carpentry joints. (K3)
CO2: prepare pipe connections with different joints for domestic applications. (K3)
CO3: make simple components using sheet metal (K3)
CO4: make components using machining operations (K3)
CO5: explain the types of welding processes (K2)
CO6: discuss the applications of 3D printing and injection moulding processes (K2)

LIST OF EXPERIMENTS

I. CARPENTRY PRACTICES **5**

1. Study of the joints in roofs, doors, windows and furniture.
2. Hands on exercise with application

II. PLUMBING PRACTICES **5**

1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
2. Study of pipe connections requirements for pumps and turbines.
3. Preparation of plumbing line sketches for water supply and sewage works.
4. Hands on exercise with application

III. SHEET METAL PRACTICES **5**

1. Forming and Bending
2. Model making: Tray, Conical Funnel etc.

IV. MACHINING PRACTICES **5**

1. Simple Turning
2. Drilling Practice
3. Model making: Shaft, stiffener plate, square flange, etc.
4. Demonstration of machining process in Vertical Machining Centre (VMC)

V. METAL JOINING PROCESS **5**

1. Demonstration of Gas, Arc and TIG Welding

VI. ADDITIVE MANUFACTURING AND INJECTION MOULDING PROCESSES **5**

1. Demonstration of 3D Scanning and Printing
2. Demonstration of Injection Moulding process

P:30; TOTAL: 30 PERIODS

TEXT BOOKS

1. BawaH.S,"WorkshopPractice",TataMcGrawHillPublishingCompanyLimited,2007

REFERENCES

1. Ramesh Babu V, "Engineering Practices Laboratory Manual", RevisedEdition,VRB Publishers Private Limited,Chennai,2014.
2. JeyachandranK, Natarajan S.andBalasubramanianS, "APrimeronEngineering PracticesLaboratory",AnuradhaPublications,2007.
3. Jeyapoovan T, Saravanapandian M. and Pranitha S, "Engineering Practices Lab Manual", VikasPublishingHousePrivateLimited,2006.
4. RajendraPrasadA andSarma PMMS,"WorkshopPractice",SreeSaiPublication,2002
5. KannaiahP andNarayana KL,"ManualonWorkshopPractice",ScitechPublications,1999.

PART B – ELECTRICAL AND ELECTRONICS LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: perform residential house wiring (K2)
CO2: identify faults in any electrical appliances (K2)
CO3: measure energy and resistance to earth of electrical equipment (K2)
CO4: measure AC signal parameters using CRO (K2)
CO5: apply soldering for electronic circuit formation in PCB (K2)

LIST OF EXPERIMENTS

ELECTRICAL

1. Residential House Wiring using Switches, Fuse, Indicator, Lamp and Energy Meter.
2. Stair Case Wiring Connections
3. Measurement of Energy using Energy Meter for Single Phase System.
4. Measurement of Earth Resistance using Electrical Equipment.
5. Study of Emergency Lamp, Choke, Starter, Fan and Iron Box
6. Coil Rewinding for Transformer and Fan using Rewinding Machine.
7. Connection of protective devices

ELECTRONICS

8. Study of Resistor, capacitor and inductor
9. Study and Operation of Digital Multimeter, Function/Signal Generator and Regulated Power Supply.
10. Measurement of AC signal parameter (Peak-Peak, RMS, Period and Frequency) using CRO and DSO.
11. Soldering Practice
12. Study of logic gates AND, OR, NOT, NAND, NOR and EXOR.
13. Half Wave Rectifier and Full Wave Rectifier.

P: 30; TOTAL: 30PERIODS

REFERENCES

1. Jeyachandran K, Natarajan S and Balasubramanian S, "A Primer on Engineering Practices Laboratory", Anuradha Publications, 2007.
2. Jeyapoovan T, Saravanapandian M and Pranitha S, "Engineering Practices Lab Manual", Vikas Publishing House Pvt. Ltd, 2006.
3. Bawa H.S., "Workshop Practice", Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A and Sarma P.M.M.S., "Workshop Practice", Sree Sai Publication, 2002.
5. Kannaiah P and Narayana K.L., "Manual on Workshop Practice", Scitech Publications, 1999.

19ME21C **PROFESSIONAL ENGLISH** **L T P C**

(Common to all B.E. / B.Tech. Degree Programmes) **2 0 0 2**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: Integrate and apply the acquired skills in real life situation. (K3)
CO 2: Write effectively in any professional contexts. (K3)
CO 3: Enhance the vital sub-functions of communication in any formal situation. (K3)
CO 4: Participate actively in any informal and formal discussion. (K3)
CO 5: Recall the acquired skills and apply them in their work place. (K2)

UNIT I **6**

Standard Abbreviations - If Conditionals - Presenting articles based on newspaper reading - Listening for specific information - Argumentative essay.

UNIT II **6**

One word substitution - Rearranging the jumbled phrases of sentences – Chart Description - Business Letters for Quotations and Clarification.

UNIT III **6**

Idioms and Phrases - Direct & Indirect Speech - Business Letters for Placing orders and Making Complaints - Process Description.

UNIT IV **6**

Synonyms **-** Group Discussion (Uses – Structure – Strategies – Team Work – Positive & Negative Body Languages – Samples - Demo) - Proposal Writing.

UNIT V **6**

Error Spotting (Based on Concord, Pronouns, Articles & Adverb Placement) - Job Application Letter & Resume Preparation - Circular and Minutes of the meeting - Reading Comprehension.

Suggested Activity: Career Analysis – Herein the students will be required to submit a report about their dream career / company of their choice. This will be followed by a presentation of the same in the class.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. Board of editors. "Fluency in English A Course book for Engineering and Technology",
   Orient Blackswan, Hyderabad, 2016.
2. Bovee, Courtland, L., John V.Thill. "Business Communication Today", 13th Edition, Pearson Education, New Delhi, 2018.

REFERENCES

1. Lester Mark and Larry Beason, "Hand book of English Grammar and Usage", McGraw Hill Education, 1st Edition, 2017.
2. Raman, Meenakshi and Sharma, Sangeetha, "Technical Communication Principles and Practice", Oxford University Press, New Delhi, 2014.

19ME22C **APPLIED MATHEMATICS** **L T P C**
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: calculate the Fourier series solution of Wave and Heat equations. (K3)
CO2: evaluate area and volume using double and triple integrals. (K3)
CO3: analyze the concepts related to vector calculus. (K3)
CO4: grasp Analytic functions and their properties. (K2)
CO5: evaluate complex integration over contour. (K3)

UNIT I BOUNDARY VALUE PROBLEMS **12**

Fundamentals of Fourier series - Half range sine and cosine series, Parseval's theorem - Fourier series solutions of one dimensional wave equation - One dimensional heat equation - Steady state solution of two dimensional heat equation.

UNIT II INTEGRAL CALCULUS **12**

Evaluation of double and triple integrals- Change of order of integration - Change of variables - Cartesian to polar coordinates- Area and volume - Beta and Gamma integrals - Definite integrals in terms of Beta and Gamma functions.

UNIT III VECTOR CALCULUS 12

Gradient, Divergence and Curl –Directional derivatives – Irrotational and solenoidal vector fields -Vector integration–Line, Surface and Volume Integrals –Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem–Simple applications involving cubes and rectangular parallelopipeds.

UNIT IV ANALYTIC FUNCTIONS 12

Analytic functions - Necessary and Sufficient conditions - Harmonic and orthogonal properties of analytic functions - Harmonic conjugate - Construction of analytic functions - Conformal mapping: w= z+c, cz, 1/z and bilinear transformation.

UNIT V COMPLEX INTEGRATION 12

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's expansions - Singular points - Residues - Residue theorem - application of residue theorem to evaluate real integrals - unit circle and semi-circular contour

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Grewal.B.S. "Higher Engineering Mathematics", Khanna Publications, New Delhi, 44th Edition, 2017.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, 10th Edition, 2011.

REFERENCES

1. Bali N.P. and Manish Goyal, "Text book of Engineering Mathematics", Laxmi Publications (P) Ltd., 9th Edition, 2017.
2. Ramana B.V., "Higher Engineering Mathematics", Tata Mc-Graw Hill Publishing company, 6th Edition, New Delhi, 2008.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publishing House Private Limited, 5th Edition, 2016.

19ME23C PHYSICS OF MATERIALS L T P C
2 0 0 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the mechanical properties of materials (K2)
CO2: acquire knowledge on thermal properties of materials (K2)
CO3: summarize the physics underlying the magnetic and superconducting behaviour of materials. (K2)
CO4: predict the mechanism by which the electric field interacts with material and their applications.(K2)
CO5: understand the different types of solar energy materials. (K2)

UNIT I MECHANICAL PROPERTIES OF MATERIALS 6

Elasticity-Modulus of Elasticity-Twisting couple on a wire-Torsion pendulum-Theory of bending moment-Young's modulus-Uniform bending method – I-Shaped Girders.

UNIT II THERMAL PROPERTIES OF MATERIALS 6

Modes of heat transfer - Rectilinear flow of heat along a metal bar - Methods of radial flow of heat - Spherical shell method and cylindrical shell method - Thermal conductivity of a poor conductor – Lee's disc method.

UNIT III MAGNETIC MATERIALS AND SUPERCONDUCTING MATERIALS 6

Basic definitions-Dia, Para magnetic materials - Ferromagnetism – Domain theory - Hysteresis – Hard and soft magnetic materials

Superconductivity – Properties - BCS theory - Type I and Type II Superconductors - Applications

UNIT IV DIELECTRIC MATERIALS 6

Dielectric constant – Local field - Clausius Mosotti relation – Types of polarization – Frequency and temperature effects on polarization – Dielectric loss - Dielectric breakdown

UNIT V SOLAR ENERGY MATERIALS 6

Solar collector materials – Glazing materials – Absorber materials - Insulation materials - Reflecting materials – Phase change materials.

Photovoltaic materials – Direct and indirect band-gap materials – Solar grade silicon – Mono and multi crystalline silicon solar cells – CIGS – Dye sensitised solar cells – Organic cells.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. William D.Callister,Jr, David G. Rethwisch "Materials Science and Engineering - An Introduction", John-Wiley and Sons, 10th Edition, 2018
2. Charles Kittel, "Introduction to Solid State Physics", John Wiley and Sons, 8thEdition, Singapore, 2012.

REFERENCES

1. Joe Kachan, "Thermal Properties of Matter" Morgan and Claypool Publishers, 1stEdition, 2018
2. Charles P. Poole Jr. , Horacio A. Farach, Richard J.Creswick,Ruslan Prozorov, "Superconductivity", Elsevier, 3rdEdition, 2018
3. Chetan Singh Solanki, "Solar Photovoltaics, fundamentals, technology and applications", PHI Publication, 3rdEdition, 2015
4. Pelleg, Joshua, "Mechanical Properties of Materials", Springer Netherlands, 1stEdition, 2013
5. K.H.J.Bushchow, "Handbook of Magnetic materials", Elsevier, 1stEdition, 2014

19ME24C CHEMISTRY FOR MECHANICAL ENGINEERING L T P C
2 0 0 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: apply the phase rule to two component systems and know the variousheat treatment processes. (K2)

CO2: familiar with thermodynamic functions and Ellingham diagrams. (K2)

CO3: know different synthetic procedures of biofuels and numerical problems related to combustion. (K2)
CO4: understand the principle and process of various surface coatings. (K2)
CO5: acquire the knowledge about applications of nanocomposites materials. (K2)

UNIT I PHASE RULE AND ALLOYS 6

Gibb's Phase rule-Application - two component system - Lead-silver system, Fe-Carbon alloy system-Heat treatment of steel- Non Ferrous Alloys.

UNIT II FREE ENERGY IN CHEMICAL EQUILIBRIA 6

Thermodynamic functions: entropy and free energy- Estimations of entropy and free energies-Free energy and emf - Use of free energy considerations in metallurgy through Ellingham diagrams.

UNIT III FUELS AND COMBUSTION 6

Coal - proximate and ultimate analysis – carbonization.
combustion: calorific value - higher and lower calorific values- theoretical calculation of calorific value-calculation of minimum amount of air for combustion.
Biofuels: Fundamental concepts – production - Biomass feedstock - Bioethanol production - Biodiesel: production from oil seeds, waste oils and algae – Biogas; synthesis -flue gas analysis.

UNIT IV SURFACE COATING 6

Introduction-metallic coating- determination of throwing power-electroplating of chromium-Electroless plating- nickel plating. Paints-constituents - multilayer coating on aluminium - zinc pasivation - anodizing.

UNIT V NANOCOMPOSITES 6

Types of nanocomposites - polymer matrix-synthesis -mechanical alloying, sol-gel, solutions mixing, in-situ polymerization and bioassisted methods – characterization – Applications in mechanical, electrical and optical field.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. P.C. Jain and M. Jain., "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2016.
2. S.S Dara and S.S Umare, A text Book of Engineering Chemistry, S. Chand & Company Ltd, 20th Edition 2018.

REFERENCES

1. A. A. Tracton, "Coating materials and surface coatings" CRC press, Taylor & Francis,4th Edition, 2016.
2. B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal, Principles of physical chemistry– Publishing Co.; 47th Edition, 2017.
3. A. K. Haghi and O.S. Oluwafemi, Composites and Nanocomposites, Taylor and Francis (CRC Press), 3rd Edition, 2015.
4. A.H. Scragg, Biofuels: Production, Application and Development, CAB International, Oxfordshire, 4th Edition, 2017.

19ME25C ENGINEERING MECHANICS L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: apply basic laws of mechanics to solve the problems on statics of particles. (K2)

CO2: draw free body diagram and apply equilibrium principles for two dimensional rigid bodies. (K3)

CO3: determine the centroid and moment of inertia of plane lamina. (K2)

CO4: apply fundamental principles to solve problems in dynamics of particles. (K3)

CO5: summarize the basic principles of friction and general plane motion. (K2)

UNIT I BASICS AND STATICS OF PARTICLES 12

Laws of Mechanics – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force – Vectorial representation of forces.

UNIT II EQUILIBRIUM OF RIGID BODIES12

Free body diagram – Types of supports and their reactions – Moments and Couples – Moment of a force about a point and about an axis, Vectorial representation of moments and couples – Scalar components of a moment – Equilibrium of Rigid bodies in two dimensions.

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Determination of centroid of areas, volumes and mass - Pappus and Guldinus theorems - moment of inertia of plane areas - Parallel and perpendicular axis theorem - radius of gyration.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements - Velocity and acceleration, their relationship – Projectile motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Frictional force -Laws of friction -Simple contact friction – Rolling resistance – Belt friction – Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

L: 45; T:15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Hibbeler RC, "Engineering Mechanics: Statics & Dynamics", Pearson India Education Services Private Limited, 13th Edition, 2012.
2. Beer FP, Mazurek DF, Sanghi S, Eisenberg ER, Johnston ER and Cornwell PJ, "Vector Mechanics for Engineers: Statics and Dynamics", Tata Mcgraw Hill Education Private Limited, 10th Edition, 2012.

REFERENCES

1. Rajasekaran S and Sankarasubramanian G, "Fundamentals of Engineering Mechanics", Vikas Publishing House Private Limited, 3rd Edition,2010.

2. Irving H Shames, "Engineering Mechanics – Statics and Dynamics", Pearson Education Asia Private Limited, 4th Edition,2003.
3. Ashok Gupta, "Interactive Engineering Mechanics–Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Private Limited, 2002.
4. Palanichamy M.S and Nagam S, "Engineering Mechanics – Statics and Dynamics", Tata McGraw Hill, 3rd Edition, 2004.

19ME26C BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explain the concepts of basic electrical circuits (K2)
CO2: describe the working principles of electrical machines and instruments (K2)
CO3: outline the functions of the component of low voltage electrical installations (K2)
CO4: explain the characteristics and applications of semiconductor devices (K2)
CO5: recall the different logic principles used in digital circuits (K2)

UNIT I CONCEPTS OF DC AND AC ELECTRICAL CIRCUITS 9

Electrical Circuit Elements – Ideal and Practical Sources – Electrical Quantities: Voltage, Current, Power and Energy – Ohms Law – Kirchoffs Laws – analysis of simple circuit with DC excitation- AC Circuits Fundamentals – Single Phase Circuits and Three Phase Circuits – Power and Power Factor.

UNIT II ELECTRICAL MACHINES 9

DC Machines: Types – Construction – Working Principles – Need for Starters - Speed control of DC motors.
AC Motors: Construction and Working of Single Phase and Three Phase Induction Motor – Starting and Speed Control of Induction Motors.
AC Synchronous Generators: Construction – Working Principle.
Transformers: Single Phase and Three Phase Transformers – Auto Transformers - Construction – Working Principle.

UNIT III INSTRUMENTS AND ELECTRICAL INSTALLATION 9

Instruments: Functional Elements – Principles of Measurements of Electrical Quantities: Voltage, Current, Power and Energy – Multifunction meter.
Electrical Installation: Components of LT Switchgear – Switch Fuse – MCB – ELCB – MCCB – Types of Wires and Cables – Earthing – Energy Storage devices - Elementary Calculations for Energy Consumptions and Battery Backup.

UNIT IV SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Operation, Characteristics and Applications: PN Junction Diode - Rectifiers - Zener Diode – Regulators - Bipolar Junction Transistor –CE Amplifier - FET – Opto-Electronic Devices – LEDs – Photo Diodes.

UNIT V DIGITAL ELECTRONICS 9

Binary Number System – Logic Gates – Boolean Algebra – Adders - Flip Flops– Shift Registers – Counters – ADC and DAC.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. D.P. Kothari and I.J. Kothari, "Basic Electrical and Electronics Engineering", 1st Edition, Tata McGraw Hill, 2014.
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishes, 7th Edition, 2011.
3. Thomas L. Floyd, "Digital Fundamentals", 10thEdition, Pearson Education Inc, New Delhi, 2009.
4. A.K.Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2004.

REFERENCES

1. D.C. Kulshreshtha, "Basic Electrical Engineering", Revised 1st Edition, Tata McGraw Hill, 2011.
2. L.S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
3. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
4. V.D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
5. E.O. Doebelin, "Measurement Systems – Application and Design", Tata McGraw Hill, 2003.
6. David Bell, "Electronic Devices and Circuits", Prentice Hall Private Limited, 2007.
7. M. Morris Mano, "Digital Design", 4th Edition, Pearson Education, 2007.

19ME27C PHYSICS AND CHEMISTRY LABORATORY L T P C
0 0 3 1.5

PART A PHYSICS LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: illustrate the mechanical properties of materials (K2)
CO2: study the magnetic properties of materials (K2)
CO3: demonstrate the properties of optical waves (K2)
CO4: analyze the thermal properties of materials (K2)

LIST OF EXPERIMENTS

1. Determination of young's modulus of a material of a beam by uniform bending method
2. Determination of moment of inertia of the disc and rigidity modulus of the wire using torsion pendulum
3. BH curve - Hysteresis method
4. Determination of wavelength of prominent spectral lines using spectrometer
5. Determination of thermal conductivity of a bad conductor using Lee's disc method

6. Determination of radius of curvature of a plano convex lens using Newton's rings Method
7. V-I Characteristics of solar cell

- A minimum of FIVE experiments shall be offered.

REFERENCES

1. R.K.Shukla, Anchal Srivastava, "Practical Physics", 3rd Edition, New Age Private Limited, 2017
2. David Loyal, " Physics laboratory", Cengage learning, 4th Edition, 2013
3. Sesha Sai Kumar Vemula, "Engineering Physics lab manual" LAP LAMBERT Academic Publishing, 1st Edition, 2017

PART B CHEMISTRY LABORATORY

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: estimate the amount of ions using various analytical techniques. (K2)
CO2: synthesize biodiesel from waste vegetable oil. (K2)
CO 3:estimate the free acid value of given oil sample. (K2)
CO4: estimate the calcium ion by pH metric methods. (K2)

LIST OF EXPERIMENTS

1. Estimation of Fe(II) by potentiometric method.
2. Estimation of copper in brass by EDTA method.
3. Synthesis of biodiesel.
4. Estimation of the free acid value of biodiesel.
5. Estimation of the iodine value of biodiesel.
6. Estimation of calcium in limestone.
7. Synthesis of silver nano particles.

P: 45; TOTAL: 45 PERIODS

- A minimum of FIVE experiments shall be offered.
- Laboratory classes on alternate weeks for Physics and Chemistry.

REFERENCES

1. D.C. Harris, "Quantitative Chemical Analysis: International Edition", 9th Edition, W.H.Freeman, 2016.
2. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J.Hannaford, P.W.G. Smith, Vogel's Textbook of Practical Organic Chemistry, Pearson Education Limited, England, 8th Edition, 2015.
3. M. Nath, Inorganic Chemistry: A Laboratory Manual, Alpha Science, New Delhi, 2016.

19ME28C	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: demonstrate the common components with different rating and use the instruments. (K2)

CO2: analyze the basic electrical circuits (K2)

CO3: infer the characteristics of electrical machines (K2)

CO4: demonstrate the functionality and characteristics of electronics devices. (K2)

LIST OF EXPERIMENTS

1. Basic Safety Precautions, Practical Circuit Elements and Measuring Instruments – Voltmeter, Ammeter, Wattmeter and Energy Meter
2. Verification of Ohms Law and Kirchoff Laws
3. Load test of Single Phase Transformer
4. Load test on DC Shunt Motor
5. Load test on DC Series Motor
6. Load test on Single Phase Induction Motor
7. Load test on Three Phase Induction Motor
8. Experimental Verification of PN Junction diode Characteristics.
9. Experimental Verification of Zener Diode Characteristics and Zener Diode as Voltage Regulator
10. Input and Output Characteristics of BJT in CE Configuration
11. Truth Tables and Functionality of Flip Flops

P: 45; TOTAL: 45 PERIODS

19ME29C	DRAFTING AND MODELING LABORATORY	L	T	P	C
		0	0	3	1.5

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Draw different 2D views of given solid model using manual and computer assisted techniques. (K3)

CO2: Perform 2D Drafting of given machine elements using software tools. (K3)

CO3: Draw sectional views of machine elements using computer assisted techniques. (K3)

CO4: Create 3D model of simple machine components using CAD software. (K3)

CO5: Interpret industrial drawing. (K3)

LIST OF EXERCISES

1. Manual and computer assisted 2D drawing of simple solid model.
   Examples: Support Bracket, Machine Block, Shaft Support, Sliding block, Shaft bracket etc.
2. 2D drafting of given machine element.

Examples: Simple Pulley, bolts and nuts, spur and helical gear profiles, clamping units, hooks, couplings, L-clamps etc.

3. Sectional views of machine elements using computer assisted techniques.
   Examples: Machine vice, Support Bracket, Machine Block, Shaft Support, Sliding block, Shaft bracket etc.
4. Modeling of simple machine components using software assisted techniques.
   Examples: Couplings, Linear Bush, Machine Block, Flexible joints, gear profiles, hand wheels, hooks, supporting and clamping units etc.
5. Reading and extracting the basic information such as dimension, machining allowance and tolerance from the given industrial drawing.

P:45; TOTAL: 45 PERIODS

TEXT BOOK

1. Narayana K.L, Kannaiah P, Venkata Reddy K"Machine Drawing",New Age International Publishers, Delhi,2016.

REFERENCES

1. Venkata Reddy K, "Text Book of Engineering Drawing", BS Publishers,Hyderabad,2008.
2. Colin H. Simmons, Denis E. Maguire, "Manual of Engineering Drawing", ButterworthHeinemann, 2012.
3. Scott Onstott, "AutoCAD 2018 and AutoCAD LT 2018", Wiley Publications, 2017.
4. Kenneth Morling, "Geometric and Engineering Drawing", Elsevier Publications, 2010.
5. Shah M.B, Rana B.C, "Engineering Drawing", Pearson Publications, 2009.
6. IS SP 46: Engineering Drawing Practice for Schools & Colleges

19GN01C INNOVATION THROUGH DESIGN THINKING L T P C
1 0 2 2

COURSE OUTCOMES

Upon Successful completion of this course, the students will be able to

CO1: To discuss the design thinking process and innovation. (K2)

CO2: Practice design thinking process through a multidisciplinary task. (K3)

UNIT I BASICS OF DESIGN THINKING PROCESS 15

Design thinking process basics-Ideation tools-case studies.

UNIT II PRACTICING DESIGN THINKING PROCESS 30

Real world problem selection-Practicing the preliminary stages of Design Thinking Process - work presentation.

L: 15; P: 30; TOTAL: 45 PERIODS

REFERENCES

1. Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, "Design Thinking: The Handbook", WS Professional, 2020
2. Pavan Soni, "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem solving", Penguin Random House, 2020

3. D.M. Arvind Mallik, “Design Thinking for Educators”, Notion Press, 2019
4. Michael Lewrick, “The Design Thinking Playbook”, Wiley, 2019
5. Kathryn Christopher, “Design Thinking in Engineering”, Kendall Hunt Publishing Company, 2019
6. Robert Curedale, “Design Thinking Process & Methods” 5th Edition, Design Community College Inc, 2019
7. David Lee, “Design Thinking in the Classroom”, Ulysses Press, 2018
8. Jimmy Jain, “Design Thinking for Startups”, Notion Press, 2018
9. Monika Hestad Silvia Rigoni Anders Grnli, “The Little Booklet on Design Thinking: An Introduction”, 2nd Edition, Zaccheus Entertainment, 2017
10. Scott Swan, Michael G. Luchs and Abbie Griffin, “Design Thinking: New Product Development Essentials”, Wiley-Blackwell, 2016
11. Thomas Lockwood, “Design Thinking: Integrating Innovation, Customer Experience, and Brand Value”, Allworth Press, 2009

MENTOR ACTIVITIES:

Educating the design thinking process: basics, Ideation tools and empathy map through case studies - presentation	10 Hours
Forming multidisciplinary batches among the students- Guide the batches to select a real-world task- Apply and practice the different stages of Design thinking process to bring out innovative solutions	20 Hours
Evaluating the students‘ activities through their presentations	

End semester Assessments can be made through:

- Design Thinking presentation(PowerPoint format)
- Design Thinking poster preparation and presentation (PDF format, in color and monochrome, printable in A3 size)

Other points:

This course is for all department students

- A class/section should be with all department students
- A course instructor will be responsible for the academic process.
- In a project batch, maximum number of students should be four and no two students from same discipline possibly.
- The course has no pre-requisite and may be offered to second/fourth semester students.

19ME31C PROBABILITY, STATISTICS AND NUMERICAL METHODS L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Grasp basic probability concepts and standard distributions. (K2)
CO2: Perform the ideas related to two dimensional random variables. (K2)
CO3: Calculate the various measures of dispersion. (K3)
CO4: Perform numerical differentiation and integration. (K3)
CO5: Solve differential equations using numerical methods. (K3)

UNIT I RANDOM VARIABLES 12

Random Variables - Discrete and Continuous random variables – Moments –Moments generating functions with properties – Binomial, Poisson, Geometric, Exponential, Gamma and Normal Distributions.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint Distribution – Marginal and Conditional Distribution – Covariance – Correlation and Regression. Transformation of Random variables.

UNIT III STATISTICS 12

Central tendencies - Mean, Median, Mode - Measures of Dispersion –Mean deviation and Quartile deviation–Moments–Skewness –Kurtosis- Correlation and Regression.

UNIT IV NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS, NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Solution of Algebraic and transcendental linear equations - Newton - Raphson Method-Solution of simultaneous equations – Gauss Elimination method – Gauss Seidel method – Interpolation – Newton's forward and backward formulae - Numerical Differentiation – Newton's forward difference and backward difference formula – Numerical integration - Single and double integration using Trapezoidal and Simpson's rules.

UNIT V NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS 12

Taylor's Series Method - Euler's Method – Runge Kutta fourth order Method – Predictor - corrector Methods - Milne's Method - Solution of one-dimensional heat equation by explicit and implicit methods - Two dimensional Laplace and Poisson equations – Liebman's Iteration Process.

L:45; T:15; TOTAL:60 PERIODS

TEXT BOOKS

1. Oliver C. Ibe, "Fundamentals of Applied Probability and Random processes", Elsevier, 1st Indian Reprint, 2007.
2. Peebles Jr. P.Z., "Probability Random Variables and Random Signal Principles", 4th Edition, Tata McGraw-Hill Publishers, New Delhi, 2002.
3. Grewal.B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publications,Delhi, 2017.

REFERENCES

1. Miller.S.L and Childers, S.L, "Probability and Random Processes with applications to Signal Processing and Communications", Elsevier Inc., 1st Indian Reprint 2007.
2. Richard Arnold Johnson, Irwin Miller, John E Freund, "Miller and Freund's Probability and Statistics for Engineers", 8th Edition, Pearson Education Private Limited, 2013.
3. Robert V.Hogg, Joseph W.Mckean, Allen Thornton Craig, "Introduction to Mathematical Statistics", 6th Edition, Pearson Education Private Limited, 2005.
4. K.Shankar Rao, "Numerical Methods for Scientists and Engineers", 3rd Edition, Prentice Hall of India,2008.
5. M.K.Jain, S.R.K.Iyengar&R.K.Jain, "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Private Limited Publishers, 2012.

19ME32C **COMPUTER PROGRAMMING** **L T P C**
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply the basic concepts to solve simple problems. (K3)

CO2: Use array and make decisions based on the problem and solve it by selection of appropriate technique (K2)

CO3: Analyze the difficulties of problems using functions. (K3)

CO4: Analyze and apply different sorting and searching techniques to solve the problem.(K3)

UNIT I INTRODUCTION 9

Introduction: Types of Problem, Computer-based problem solving, Difficulties in problem solving, Program design, implementation issues, Applications. Programming environment, Data Storage and Communication with Computer, Organizing the Problem. Algorithms for problem solving: Algorithms and flow charts, flowchart symbols, design of algorithms for simple and scientific problems, divide and conquer strategy.

UNIT II DECISION MAKING AND LOOPING 9

Sequential Logic Structure, Decision Making, Looping Techniques, Multi-Way Decision Making. Array: Reading, Writing, Processing, Sorting, Evaluating Polynomial. Sum and Difference, Trace, Transpose of Matrices.

UNIT III FUNCTIONS 9

String handling functions. User defined Functions: Definition – Declaration – Function calls – Category of Functions – Recursion - Storage Classes.

UNIT IV SORTING TECHNIQUES 9

Sorting: Bubble Sort, Selection Sort, Insertion Sort, Postman Sort, Quick Sort, Merge Sort, Radix Sort, Applications.

UNIT V SEARCHINGTECHNIQUES 9

Searching algorithms: Linear search, Binary search, Fibonacci search, Golden-ratio selection, Golden section search method, Applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Ashok.N.Kamthane, Computer Programming and IT, Pearson Education India, 2016
2. Anita Goel, Ajay Mittal,"Computer Fundamentals and Programming in C (RMK)", Pearson Education India, 2016
3. R.G. Chaudhari, Training Techniques of Creative problem Solving, Notion Press, 2018.

REFERENCES

1. Maureen Sprankle and Jim Hubbard, Problem Solving and Programming Concepts‖, 9th Edition, Prentice Hall, 2012.
2. Teodor Rus, Computer-Based Problem-Solving Process, The university of Iowa, USA, 2015.

19ME33C THERMODYNAMICS L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the thermodynamic systems and apply first law of thermodynamics to analyze the systems. (K3)

CO2: Discuss second law of thermodynamics and its corollaries, and analyze the feasibility of a process based on first and second law of thermodynamics. (K3)

CO3: Evaluate the change in properties of ideal and real gases subjected to thermodynamics processes using equation /table/ chart. (K2)

CO4: Calculate the change in properties of steam subjected to thermodynamics processes using equation/table/chart. (K2)

CO5: Determine the change in properties of atmospheric air subjected to psychrometric processes using equation/chart. (K2)

UNIT I BASIC CONCEPT AND FIRST LAW OF THERMODYNAMICS 12

Thermodynamic system - concepts - Zeroth law of thermodynamics - Heat and work transfer - First law of thermodynamics in flow and non-flow processes.

UNIT II SECOND LAW OF THERMODYNAMICS 12

Thermal energy reservoir-heat engines and heat pumps - Kelvin and Clausius statements- Reversible and irreversible processes - Carnot cycle and theorem - Clausius inequality - Concept of Entropy - Increase of entropy principle.

UNIT III IDEAL AND REAL GASES AND THERMODYNAMICRELATIONS 12

Gas mixtures - properties of ideal and real gases - equation of state – Avogadro's Law - Vander Waal's equation of state - compressibility factor - compressibility chart – Dalton's law of partial pressure - Exact differentials - T-D relations – Maxwell's relations - Clausius Clapeyron equations - Joule Thomson coefficient.

UNIT IV PROPERTIES OF PURE SUBSTANCE 12

Pure substances - Phase change - Property diagrams - Property tables - thermodynamic properties of steam - Calculations of work done and heat transfer in non-flow and flow processes.

UNIT V PSYCHROMETRY 12

Psychrometry and psychrometric charts - property calculations of air vapour mixtures – Simple Psychrometric processes - Evaporative cooling.

Note: (Use of steam tables and psychrometric chart are permitted in the End Semester Examination)

L: 45; T:15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Yunus A Cengel and Michael A Boles, "Thermodynamics - An Engineering Approach", 8thEdition, Tata McGraw-Hill Education, 2015.
2. Nag P.K, "Engineering Thermodynamics", 6thEdition, the McGraw-Hill Book Company, 2017.

REFERENCES

1. Sonntag, Borgnakke and Van Wylen, "Fundamentals of Thermodynamics", 7th Edition, Wiley India Private Limited, 2009.
2. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering Thermodynamics: 8th Edition, John Wiley & Sons, 2015
3. Rajput RK, "A Textbook of Engineering Thermodynamics", 4th Edition, Laxmi Publications Private Limited, 2015.
4. NPTEL Videos: http://nptel.ac.in/video.php?subjectId=112105123.

19ME34C MANUFACTURING TECHNOLOGY– I L T P C
2 0 2 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Elucidate and select appropriate casting method for a productand design the gating and riser systems (K3)

CO 2: Identify and select suitable metal joining process for fabrication and prepare weld joints in laboratory (K3)

CO 3: Discuss and practice the metal forming processes and calculate the load requirement in forming processes (K3)

CO 4: Explain the various stages in component preparation through powder metallurgy technique (K2)

CO 5: Discuss various polymer processing methods and applications (K2)

UNIT I METAL CASTING PROCESSES 12

Sand casting- Moulding sand: types, properties and testing methods- Patterns: materials and allowances – Core making process –Heat transfer and solidification in casting-Riser and gating design– Working principle of Special casting processes-Recent developments in casting– Casting defects. Preparation of mould using green sand and split pattern in laboratory.

UNIT II METAL JOINING PROCESSES 12

Fusion and solidstate welding processes –Brazing, soldering and adhesive bonding processes–Recent developments in welding-Weld defects. Practicing with TIG welding for making simple weld joints in laboratory.

UNIT III METAL FORMING PROCESSES 12

Hot working and cold working of metals – forging, rolling, drawing and extrusion processes- principles and applications- Sheet metal forming processes- principles and applications-Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet(shearing, deep drawing, bending) metal forming processes-Recent developments in forming. Preparation of simple objects through hot forging and simple sheet metal parts in laboratory.

UNIT IV POWDER METALLURGY 12

Metallic Powder preparation: Mechanical, Physical and chemical methods- Powder treatment and handling. Powder compaction: Pressure and Pressure less compaction methods. Sintering: Solid state, Liquid state and activated sintering processes. Secondary operations on part prepared through powder metallurgy. Recent developments and Industrial applications.

UNIT V PROCESSESING OF PLASTICS 12

Types of plastics- plastic processing techniques: Blow moulding, Injection moulding (screw and plunger type machines), Rotational moulding, Transfer moulding and compression moulding- Recycling and Eco-friendlyProcessing-Recent developments and Industrial applications.

L:30; P:30; TOTAL: 60 PERIODS

TEXT BOOKS

1. HajraChoudhury, "Elements of Workshop Technology, Vol.I Manufacturing Processes", Media Promotors Private Limited, Mumbai, 15th Reprint, 2016.
2. S.Gowri, P.Hariharan and A.SureshBabu, "Manufacturing Technology 1", Pearson Education, 2017.

REFERENCES

1. B.S. MagendranParashar&R.K.Mittal, "Elements of Manufacturing Processes", Prentice Hall of India, 2003.
2. P.N.Rao, "Manufacturing Technology", 2nd Edition, Tata McGraw-Hill Publishing Limited, 2015.
3. P.C. Sharma, "A Text book of Production Technology", 11th Edition, S.Chand and Company, 2013.
4. Begman, "Manufacturing Process", 8th Edition, John Wiley & Sons, 2018.
5. SeropeKalpajian, Steven R.Schmid, "Manufacturing Engineering and Technology", PearsonEducation, Inc. 2018 (2nd Indian Reprint).
6. Beddoes.J and Bibby M.J, "Principles of Metal Manufacturing Processes", Elsevier, 2016.
7. Rajput R.K, "A text book of Manufacturing Technology", Lakshmi Publications, 2016.
8. Larry Jeffus, "Welding and Metal Fabrication", Cengage Learning, 2012.

19ME35C KINEMATICS OF MACHINERY L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the simple mechanisms with suitable examples. (K2)
CO2: Determine velocity and acceleration of any point on a link in simple mechanisms. (K2)
CO3: Draw different cam profile for various follower motions. (K2)
CO4: Describe laws of gearing, types of gears, terminologies of spur gears and gear trains. (K2)
CO5: Discuss the concept of friction in drives and brakes. (K2)

UNIT I BASICS OF MECHANISM 12

Definitions – Link, Kinematic pair, Kinematic chain, Mechanism and Machine – Degrees of Freedom – Mobility – Kutzbach criterion (Gruebler's equation) – Grashoff's law- Kinematic inversions of four-bar chain and single slider crank chain – Mechanical Advantage-Transmission angle. Description of common mechanisms – Offset slider mechanism as quick return mechanisms, pantograph, straight line generators (Peaucellier and Watt mechanisms).

UNIT II KINEMATIC ANALYSIS 12

Analysis of velocity and acceleration in simple mechanisms – Graphical Methods for relative velocity and acceleration polygons –Coriolis acceleration.

UNIT III KINEMATICS OF CAMS 12

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

UNIT IV GEARS 12

Types of Gears – Spur gear terminology and definitions – Law of toothed gearing – Involute and cycloidal gear profiles- Interchangeability – Interference and undercutting. Gear trains – Simple, compound and Epicyclic gear trains–speed calculation.

UNIT V FRICTION DRIVES 12

Dry friction, Friction in screw threads – Friction clutch - types –single plate, Multi plate and cone clutch. –Block brakes, band brakes. Conditions for self-locking and self energizing.

L:45; T:15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Rattan SS, "Theory of Machines", Tata McGraw – Hill Publishers, New Delhi, 2017.
2. Robert L Norton, "Design of Machinery", 5th Edition, McGraw-Hill Higher Education, 2013.

REFERENCES

1. Uicker JJ, Pennock GR andShigley JE, "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2017.
2. Ambekar AG, "Mechanism and Machine Theory", 1st Edition, Prentice Hall of India, New Delhi, 2011.
3. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2009.
4. Ramamurti V, "Mechanism and Machine Theory", 2nd Edition, Narosa Publishing House,Reprint 2019.
5. Cleghorn W.L., Mechanisms of Machines, Oxford University Press, 2nd Edition, 2014.

19MC02C **CONSTITUTION OF INDIA** **L T P C**
3 0 0 0

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the salient features of the Indian Constitution. (K2)
CO2: discuss the structure and functions of parliament. (K2)
CO3: elaborate the structure and functions of state legislature. (K2)
CO4: explain the fundamentals of organization and working of the Judiciary. (K2)
CO5: discuss the foreign policy of India. (K2)

UNIT I INDIAN CONSTITUTION 9

Salient Features – Preamble-Pillars of constitution - Fundamental Rights – Directive Principles of State Policy - Fundamental Duties.

UNIT II PARLIAMENTARY SYSTEM 9

Powers and Functions of President and Prime Minister - Council of Ministers - The Legislature Structure and Functions of Lok Sabha and Rajya Sabha – Speaker.

UNIT III FEDERAL SYSTEM 9

Features of Federal System - Administrative Relationship between Union and States - Powers and Functions of Governor and Chief Minister – Council of Ministers - State Legislature.

UNIT IV THE JUDICIARY 9

Organization and Composition of Judiciary - Powers and Functions of the Supreme Court - Judicial Review – High Courts.

UNIT V INTERNATIONAL POLITICS 9

Foreign Policy of India – VISA Application Process- International Institutions like UNO, WTO, SAARC and Environmentalism.

L:45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Basu D.D," Introduction to Indian Constitution", Prentice Hall of India, New Delhi, 2015.
2. Gupta D.C, "Indian Government and Politics", Vikas Publishing House, New Delhi, 2010.

REFERENCES

1. Pylee M.V, "Introduction to the Constitution of India", Vikas Publishing House, NewDelhi, 2011.
2. Kashyap S, "Our Constitution", National Book Trust, New Delhi, 2010.
3. Shukla V N, "Constitution of India", Eastern Book Company Ltd., New Delhi, 2011.

19ME36E COMPUTER PROGRAMMING LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Solve simple and Complex problems (K3)

CO 2: Solve sorting and searching problems. (K3)

LIST OF EXPERIMENTS

1. Solve problems such as temperature conversion, student grading, interest calculation, the roots of a quadratic equation
2. Design a simple arithmetic calculator. (Use switch statement)
3. Perform the following operations:
   a. Generate Pascal's triangle.
   b. Construct a Pyramid of numbers.
4. Generation of first 'n' terms of the Fibonacci sequence and prime sequence.
5. Find the 2's complement of a binary number.
6. Perform the following operations:
   a. Matrix addition.
   b. Transpose of a matrix.
   c. Matrix multiplication by checking compatibility
7. Perform the following operations on a string:
   a. Insert a sub-string into main string at a given position.
   b. Delete n characters from a given position in a string.
   c. Check whether the given string is palindrome or not.
   d. Replace a character of string either from beginning or ending or at a specified location.
   e. Write a C program to determine if the given string is a palindrome or not
8. Perform the following operations: (Use recursive functions)
   a. Find the factorial of a given integer.
   b. Find the GCD (Greatest Common Divisor) of two given integers.
   c. Solve the Towers of Hanoi problem.
9. Write C programs that implement the following sorting methods to sort a given list of integers in ascending order: i) Bubble sort ii) Selection Sort iii) Insertion sort iv) Merge sort
10. Write C programs that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers: i) Linear search ii) Binary search

Software Requirement: Turbo C / Python

P: 30; TOTAL: 30 PERIODS

REFERENCES

1. Ashok.N.Kamthane, Computer Programming and IT, Pearson Education India, 2016
2. Anita Goel, Ajay Mittal, "Computer Fundamentals and Programming in C (RMK)", Pearson Education India, 2016
3. R.G. Chaudhari, Training Techniques of Creative problem Solving, Notion Press, 2018.

19ME37C COMMUNICATION SKILLS LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Listen and respond effectively to interact at different situations fluently (K2, S3)

CO2: Excel appropriately in professional contexts. (K3, S4)

CO3: Acquire the sub-skills required for paper presentations and group discussions which will help them to excel in their workplace. (K3, S4)

UNIT I **10**

Lab session: Listening and responding to audio files

Practice session: Mini Presentation related to Business English & Picture description.

UNIT II **10**

Lab session: Role Play – News Reader

Practice session: Resume Preparation

UNIT III **10**

Lab session: Listening to audio files related to soft skills.

Practice session: Practicing Power point presentation, Group discussion

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Dutt P. Kiranmai and Rajeevan Geeta, “Basic Communication Skills”, Foundation Books, 2013.
2. Comfort, Jeremy, et al. “Speaking Effectively, Developing Speaking Skills for Business English”, Cambridge University Press, Cambridge: Reprint 2011.
3. Rizvi.M.Ashraf, “Effective Technical Communication”, The MC-Graw Hill Education Private Limited, Companies, New Delhi, 2010.

19ME41C FLUID MECHANICS AND MACHINERY L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain the fundamentals of fluid properties and solve fluid dynamics problems using Bernoulli’s equation. (K2)

CO2: Apply dimensional analysis to simple problems. (K2)

CO3: Determine flow rates, pressure changes, minor and major head losses for laminar and turbulent flows through pipes. (K2)

CO4: Apply principles of fluid mechanics to the operation, design and selection of hydraulics turbines. (K2)

CO5: Apply principles of fluid mechanics to the operation, design and selection of pumps. (K2)

UNIT I INTRODUCTION TO FLUID AND FLUID DYNAMICS 12

Properties of fluids - Flow characteristics: concepts of system and control volume- Application of control volume to continuity equation - Bernoulli's equation – applications.

UNIT II DIMENSIONAL AND MODEL ANALYSIS 12

Dimension and units - dimensionless parameters - Buckingham's π theorem - Models and similitude - Applications of dimensionless parameters, scaling factors and law.

UNIT III FLOW THROUGH CIRCULAR CONDUITS 12

Boundary layer concepts - Laminar flow though circular conduits and circular annuli - Darcy-Weisbach's equation - Flow through pipes in series and in parallel, friction factor – Moody diagram- Losses in pipes.

UNIT IV HYDRAULIC TURBINES 12

Hydro turbines: definition and classifications - working principles - velocity triangles - work done - specific speed - efficiencies - performance curves.

UNIT V HYDRAULIC PUMPS 12

Pump: Classification and working principles - Centrifugal pump velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump: slip, discharge, work done - cavitation.

L: 45; T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Bansal RK, "Fluid Mechanics and Hydraulics Machines", 10th Edition, Laxmi publications (P) Ltd, New Delhi, 2018.
2. White FM, "Fluid Mechanics", 8th Edition, Tata McGraw-Hill, New Delhi, 2016

REFERENCES

1. Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics", 3rd Edition, McGraw-Hill Ltd, New Delhi, 2014
2. Streeter VL and Wylie EB, "Fluid Mechanics", 9th Edition, McGraw-Hill Ltd, New Delhi, 2010.
3. Modi PN and Seth SM, "Hydraulics and Fluid Mechanics Including Hydraulics Machines", 20th Edition, Standard Book House, 2015.
4. Kumar KL, "Engineering Fluid Mechanics", 15th Edition, Eurasia Publishing House Private Limited, New Delhi, 2006.
5. Shiv Kumar, "Fluid Mechanics & Fluid Machines: Basic Concepts & Principles", 2nd Edition, Ane Books Pvt. Ltd., New Delhi, 2011
6. https://nptel.ac.in/courses/112105171/

19ME42C STRENGTH OF MATERIALS L T P C

3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Determine various stresses on simple load carrying members subjected to axial, shear and thermal loads. (K2)

CO2: Apply Mohr's circle to resolve stresses on inclined planes and determine stresses in thin cylinders. (K2)
CO3: Construct shear force and bending moment diagrams for beams. (K2)
CO4: Estimate slope and deflection of beams and columns. (K2)
CO5: Determine the twist and shear stresses of shaft and springs under torsional load (K2)

UNIT I SIMPLE STRESSES 12

Axial and shear stresses and strains – Elasticity, Hook's law – Lateral strain – Poisson's ratio – Volumetric strain – Elastic constants – Thermal stress – Stress in composite bars, Factor of safety.

UNIT II COMBINED STRESSES AND BIAXIAL STRESSES 12

Principal stresses and Planes. Plane of maximum shear – Mohr's circle for plane stresses. Thin cylindrical and spherical shells subjected to internal pressure, Thick cylinders – Lame's equation.

UNIT III SHEAR FORCE AND BENDING MOMENT IN BEAMS 12

Classification of beams, Shear force and Bending Moment diagrams for cantilever, simply supported beams -point loads, UDL and UVL. Bending stresses.

UNIT IV DEFLECTION OF BEAMS AND COLUMNS 12

Slope and deflection of cantilever and simply supported beams - Macaulay, Moment area and Conjugate methods - Columns and struts –Euler's and Rankine's formulae.

UNIT V TORSION 12

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stress and defection in open coil helical spring.

L: 45 T: 15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Timoshenko SP, "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi, 2004.
2. Popov EP, "Engineering Mechanics of Solids", 2nd Edition, Prentice-Hall of India, New Delhi, 2002.

REFERENCES

1. Hibbeler RC, "Mechanics of Materials", 8th Edition, Prentice Hall, 2011.
2. Ramamurtham S, "Strength of Materials", 14th Edition, Dhanpat Rai Publications, 2011.
3. Nash WA, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill Book Co., New York, 1995.
4. Kazimi SMA, "Solid Mechanics", Tata McGraw-Hill Publishing Co., New Delhi, 2003.
5. Ryder GH, "Strength of Materials", 3rd Edition, Macmillan India Limited, 2002.
6. Beer FP and Johnston R," Mechanics of Materials", 3rd Edition, McGraw-Hill Book Co., 2002.
7. Bansal RK, "Strength of Materials", Laxmi Publications, New Delhi, 2012.

8. Norman E Dowling, “Mechanical behavior of Materials – Engineering methods for Deformation, Fracture and Failure”, 4th Edition, Pearson Publications, England, 2013.
9. Prashant Kumar, “Elements of Fracture Mechanics” McGraw Hill, New Delhi, 2009.

19ME43C THERMAL ENGINEERING L T P C
3 1 0 4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain different gas power cycles with their application in IC engines and Gas turbines. (K2)
CO2: Explain steam power cycle and modify the cycle to improve the overall efficiency. (K2)
CO3: Describe and carry out the performance study on steam nozzles and turbines. (K2)
CO4: Calculate the performance of VCR and Air conditioning system. (K2)
CO5: Calculate the performance Air compressors. (K2)

UNIT I GAS POWER CYCLES 12

Otto, Diesel, Dual and Brayton cycles - I.C Engines – basics - Valve Timing and Port timing diagrams - Performance and Heat Balance of I.C. Engines.

UNIT II STEAM POWER CYCLE 12

Simple, Actual Rankine Cycle and components –Modified cycles- - Reheat, Regeneration and Combined cycles– Recent developments.

UNIT III STEAM NOZZLES AND TURBINES 12

Steam Nozzles - Effect of friction, critical pressure ratio, supersaturated flow - Steam Turbines-types - compounding, degree of reaction, velocity diagram, speed regulations, Condition for maximum efficiency – Latest developments.

UNIT IV REFRIGERATION AND AIR CONDITIONING SYSTEMS 12

VCR cycle - super heat, sub cooling - Performance calculations-Reversed Brayton cycle - VAR cycle - Ammonia - Water, Lithium bromide -water systems - Air Conditioning - Types - Cooling load calculations - Cooling towers – concept and types - Latest developments.

UNIT V AIR COMPRESSOR 12

Classification - working principle - reciprocating air compressors - work of compression and efficiency - with and without clearance - Multistage air compressor with Intercooling.

L: 45; T: 15; TOTAL: 60 PERIODS

*Note: (Use of steam tables, Refrigeration tables and psychrometric chart are permitted in the End Semester Examination)

TEXT BOOKS

1. Mahesh M Rathore, “Thermal Engineering “, Tata McGraw-Hill, New Delhi, 2010.
2. Rajput R.K, “Thermal Engineering”, 10thEdition, Laxmi Publications, Limited, 2018.

REFERENCES

1. S.M Yahya, "Turbines, Compressors and Fans", 4th Edition, Tata McGraw-Hill Education, 2010
2. Yunus A Cengel and Michael a Boles, "Thermodynamics - An Engineering Approach", 8th Edition, Tata McGraw-Hill Education, 2015.
3. Manohar Prasad "Refrigeration and Air Conditioning", 3rd Edition, New Age International Publishers, 2015.
4. Ganesan V, "Internal Combustion Engines", 4th Edition, Tata McGraw-Hill, 2012.
5. IS 10001:1981, Performance of IC Engines.
6. IS: 1391-2002 Part II, Performance test of RAC.
7. http://nptel.ac.in/courses/112105128/11.

19ME44C MANUFACTURING TECHNOLOGY– II L T P C
2 00 3

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO 1: Describe the theories of metal cutting and calculate cutting tool life, machining time and cutting forces in metal machining. (K2)
CO 2: Identify accessories and tools required to perform a particular operation in centre and semi-automatic lathes. (K2)
CO 3: Describe the constructional and operational features of various special purpose machine tools. (K2)
CO 4: Discuss the process of grinding and other surface finishing operations (K2)
CO 5: Discuss the need and process of additive manufacturing. (K2)

UNIT I THEORY OF METAL CUTTING 6

Material removal processes, types of machine tools – theory of metal cutting: cutting tool materials, tool wear and life, economics of machining, cutting fluids and cutting force measurement techniques.

UNIT II CENTRE LATHE AND SEMI-AUTOMATIC LATHES 6

Centre lathe- cutting tool geometry- taper turning and thread cutting methods. Capstan and turret lathes. Recent developments in general purpose machine tools.

UNIT III SPECIAL PURPOSE MACHINE TOOLS 6

Shaping, milling, planning and drilling operations- Indexing calculations in milling machine. Gear manufacturing processes. Recent developments in special purpose machine tools.

UNIT IV SURFACE FINISHING PROCESSES 6

Grinding wheel and various types of grinding processes, electrochemical grinding, honing, lapping and buffing processes. Recent developments in super finishing.

UNIT V ADDITIVE MANUFACTURING 6

Need and Development of AM systems - Classification of AM processes - Benefits - Applications.

L: 30; TOTAL: 30 PERIODS

TEXT BOOKS

1. HajraChoudry, "Elements of Work Shop Technology – Vol. II", Media Promoters, 2016
2. Milton C.Shaw, "Metal Cutting Principles", Oxford University Press, 4th Edition, 2016.

REFERENCES

1. Rao, P.N. "Manufacturing Technology", Metal Cutting and Machine Tools Volume 2, Tata Mc-Graw –Hill, New Delhi, 3rd Edition, 2013.
2. P.C.Sharma, "A Text Book of Production Engineering", S.Chand and Company Limited, 11thEdition, 2015.
3. Rajput R.K, "A Text book of Manufacturing Technology", Laxmi Publications, 2017.
4. Philip F.Ostwald and Jairo Munoz, "Manufacturing Processes and systems", John Wiley and Sons, 11thEdition, 2016.
5. MikellP.Groover, "Fundamentals of Modern Manufacturing, Materials, Processes and Systems", John Wiley and Sons, 5th Edition, 2015.

19ME45C MATERIALS SCIENCE AND METALLURGY L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the structure and properties of materials referring suitable phase diagrams. (K2)

CO2:Select appropriate heat-treatment techniques to impart desired properties in materials /alloys. (K2)

CO3: Describe the different types of ferrous and non -ferrous materials and their applications. (K2)

CO4: Select suitable plastics, ceramics and composites for specific engineering applications. (K2)

CO5: Explain different damage mechanisms and testing of metals (K2)

UNIT I ALLOYS AND PHASE DIAGRAMS 9

Constitution of alloys–Solid solutions, substitutional and interstitial–phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron–Iron carbide phase diagram. Classification of Steel and cast Iron - microstructure, properties and application.

UNIT II HEAT TREATMENT 9

Definition–Full annealing, stress relief, recrystallisation and spheroidising–normalising, hardening and Tempering of steel. Isothermal transformation diagrams–cooling curves superimposed on I.T. Diagram -Continuous Cooling Transformation (CCT) diagram-Austempering, Martempering –hardening methods-case hardening, carburizing, Nitriding, cyaniding, carbonitriding–Flame and Induction hardening–Vacuum and Plasma hardening - Thermo-mechanical treatments-elementary ideas on sintering.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti& W) -α and β stabilizers – stainless and tool steels–HSLA, Maraging steels–Cast Iron-Grey, white, malleable,

spheroidal–alloy cast irons, Copper and copper alloys–Brass, Bronze and Cupronickel–Aluminum and its alloys - Al-Cu–precipitation strengthening treatment– Titanium alloys, Mg-alloys, Ni-based super alloys –Properties and Applications.

UNIT IV NON-METALLIC MATERIALS 9

Polymers–types of polymer, commodity and engineering polymers–Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers–Urea and Phenol formaldehydes)-Engineering Ceramics–Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON–Composites-Classifications-Metal Matrix and FRP-Applications of Composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9

Mechanismsofplasticdeformation, slip and twinning–Types of fracture–Testing of materials under tension, compression and shear loads–Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Micro and Nano-hardness tests, Impact test Izod and Charpy, fatigue and creep failure mechanisms.

L:45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Avner, S.H."Introduction to Physical Metallurgy", McGraw Hill Education; 2nd Edition, July 2017
2. Williams D Callister, "Material Science and Engineering" Wiley India Private Limited, Revised Indian Edition, 2014

REFERENCES

1. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., Edition: 2015
2. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint 2002.
3. Upadhyay. G.S.and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2006.
4. U.C.Jindal: Material Science and Metallurgy, "Engineering Materials and Metallurgy", 1st Edition, Dorling Kindersley, 2012.

19MC03C SAFETY, HEALTH AND ENVIRONMENTAL ENGINEERING L T P C
3 0 0 0

COURSE OUTCOMES

Upon completion of the course, the students will be able to

CO1: Explain the principles of safety management in industries. (K2)
CO2: Discuss the techniques to identify and prevent the occupational diseases. (K2)
CO3: Summarize the sources and consequences of global warming. (K2)
CO4: Identify the potential sources and effects of air and water pollution. (K2)
CO5: Discuss the concepts of measurement of emissions and emission measurement

devices. (K2)

UNIT I SAFETY CONCEPTS AND TECHNIQUES 9

History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety-safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

UNIT II OCCUPATIONAL HEALTH 9

Concept and spectrum of health - functional units and activities of occupational health services, pre- employment and post-employment medical examinations - occupational elated diseases,levels of prevention of diseases, notifiable occupational diseases their effects and prevention – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests.

UNIT III GLOBAL WARMING 9

Last 30 years in global warming – greenhouse effect – greenhouse gases – Climate change – impacts of climate change: Fresh water resources, Costal areas, Sea level rise, agriculture and food supply, eco systems, human health. Global warming forecasting, Energy solutions to global warming

UNIT IV AIR AND WATER POLLUTION 9

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution-hazards of air pollution.Classification ofwater pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal

UNIT V ENVIRONMENTAL MEASUREMENT AND CONTROL 9

Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – pH meter – gas chromatograph – atomic absorption spectrometer.Gravitational settling chambers - cyclone separators – scrubbers - electrostatic precipitator – Flue Gas desulphurization.

L:45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Blake R.B., “Industrial Safety” Prentice Hall, Inc., New Jersey, 1973
2. Rao, C.S, “Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, 1992.
3. Heinrich H.W. “Industrial Accident Prevention” Mc-Graw-Hill Company, New York, 1980.

REFERENCES

1. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.
2. Rao, C.S, “Environmental Pollution Engineering, Wiley Eastern Limited, New Delhi, 1992.
3. Varma and Braner, “Air pollution equipment”, Springer Publishers, 2nd Edition.

19ME46C FLUID MECHANICS AND MACHINERY LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Apply Bernoulli's equations to determine the coefficient of discharge in flow measuring devices. (K3)

CO2: Determine head losses in various flow sections for viscous flows through pipes with simple case study. (K3)

CO3: Evaluate the performance of different types of turbines and pumps and to solve simple case study problems. (K3)

UNIT I FLUID MECHANICS 10

Bernoulli's Equation - Venturimeter - Orificemeter - Rotameter - Viscous flow through Pipes and pipe fittings.

UNIT II PERFORMANCE OF TURBINES 10

Pelton Wheel turbine - Francis Turbine - Kaplan Turbine - Performance curves.

UNIT III PERFORMANCE OF PUMPS 10

Centrifugal Pump - Reciprocating Pump - Gear oil Pump - Performance curves.

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Streeter VL and Wylie EB, "Fluid Mechanics", 9th Edition, McGraw-Hill Ltd, New Delhi, 2010.
2. Bansal RK, "Fluid Mechanics and Hydraulics Machines", 10th Edition, Laxmi publications (P) Ltd, New Delhi, 2018.
3. http://fm-nitk.vlabs.ac.in/#
4. https://eerc03-iiith.vlabs.ac.in/List%20of%20experiments.html?domain=Civil%20Engineering
5. http://mfts-iitg.vlabs.ac.in/

19ME47C THERMAL ENGINEERING LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon successful completion of this course, the students will be able to

CO1: Examine and compare the properties of different types of oils using various apparatus. (K2)

CO2: Design and conduct experiments on internal combustion engines to investigate and compare the performances. (K3)

CO3: Evaluate the performance of compressors, refrigeration and air conditioning systems (K2)

UNIT I CHARACTERIZATION OF OIL/FUEL 10

Viscosity measurement- redwood viscometer, Saybolt viscometer

UNIT II PERFORMANCE TESTS ON ENGINES 10

Performance and heat balance test - Morse test - Retardation test - Optimum load Determination

UNIT III PERFORMANCE TESTS ON THERMAL SYSTEMS 10

Compressors - Rotary - Reciprocating; Refrigeration and Air conditioning systems - Performance Tests

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Mahesh M Rathore, “Thermal Engineering “, Tata McGraw-Hill, New Delhi, 2010.
2. Rajput RK,“Thermal Engineering”, 10th Edition, Laxmi Publications, Ltd., 2018.
3. Ganesan V, “Internal Combustion Engines”, 4thEdition, Tata McGraw-Hill, 2012.
4. S.M Yahya, “Turbines, Compressors and Fans, 4/e”, 4th Edition, Tata McGraw-Hill Education, 2010
5. IS 10001:1981, Performance of IC engines.
6. IS: 1391-2002 Part II, Performance test of RAC.
7. http://vlabs.iitkgp.ernet.in/rtvlas/#

19ME48C MATERIAL TESTING LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Study the ASTM Standards for Mechanical and Wear testing of Materials
CO2: Evaluate mechanical properties experimentally for materials subjected to direct, shear and bending. (K3)
CO3: Compare hardness and impact resistance of the materials before and after heat treatment. (K4)
CO4: Perform metallurgical characterization of materials. (K3)
CO5: Analyze the strength and stiffness of helical springs. (K3)
CO6: Conduct wear test and examine the wear resistance of the material (K3)

UNIT I MECHANICAL PROPERTIES OF MATERIALS 14

ASTM and BIS Standards for Mechanical and Wear test of the materials - Mechanical properties - elastic constants, yield strength, ultimate tensile strength (UTS), S-N curve, hardness, shear strength, impact strength and torsional strength.

UNIT II STRENGTHENING MECHANISMS 4

Heat treatment - Effect of hardening and tempering - Improvement in hardness and impact resistance of steels.

UNIT III MICROSCOPY 4

Microstructural analysis - Optical microscopy.

UNIT IV SPRINGS 4

Mechanical properties - Stiffness, modulus of rigidity, maximum strain energy.

UNIT V WEAR TEST 4

Study of Wear Parameters – Pin-On-Disc Wear test – depth of wear and Coefficient of friction.

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Timoshenko SP, “Elements of Strength of Materials”, Tata McGraw-Hill, New Delhi, 2004.
2. Popov EP, “Engineering Mechanics of Solids”, 2nd Edition, Prentice-Hall of India, New Delhi, 2002.
3. Bharath Bhushan. “Introduction to Tribology”, 2nd Edition, Wiley India, 2013

19ME49C MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 2 1

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO1. Perform operations to create simple components using Lathe. (K3)
CO2. Estimate cutting forces in a single point cutting tool. (K3)
CO3. Perform shaping, slotting and milling operations. (K3)
CO4. Generate gear profile using milling and hobbing machines. (K3)
CO5. Perform surface finishing operations on simple parts. (K3)
CO6. Make simple components using 3D printer. (K3)

UNIT I CENTRE LATHE AND SEMI AUTOMATIC LATHE 8

Thread cutting with centre lathe and simple machining practices in capstan lathe. Cutting force measurement using cutting tool dynamometer.

UNIT II SPECIAL PURPOSE MACHINE TOOLS 8

Shaping, milling and slot cutting operations.

UNIT III GEAR MANUFACTURING AND ABRASIVE PROCESSES 8

Gear milling, gear hobbing and simple grinding operations.

UNIT IV ADDITIVE MANUFACTURING 6

Additive manufacturing – Making of simple components - FDM technology.

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Hajra Choudhury, “Elements of Workshop Technology, Vol. II Machine tools”, Media Promotors Private Limited, Mumbai, 15th Reprint, 2016.
2. SeropeKalpajian, Steven R.Schmid, “Manufacturing Engineering and Technology”, Pearson Education, Inc. 2018 (2nd Indian Reprint).
3. B.S. Magendran Parashar &R.K.Mittal, “Elements of Manufacturing Processes”, Prentice Hall of India, 2003.
4. P.N.Rao, “Manufacturing Technology”, 2nd Edition, Tata McGraw-Hill Publishing

Limited, 2015.
5. P.C. Sharma, “A Text book of Production Technology”, 11th Edition, S.Chand and Company, 2013.
6. Begman, “Manufacturing Process”, 8th Edition, John Wiley & Sons, 2018.
7. Beddoes.J and Bibby M.J, “Principles of Metal Manufacturing Processes”, Elsevier, 2016.
8. Rajput R.K, “A text book of Manufacturing Technology”, Lakshmi Publications, 2016.
9. Larry Jeffus, “Welding and Metal Fabrication”, Cengage Learning, 2012.

19ME51C HEAT AND MASS TRANSFER L T P C
3 1 2 5

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO1:Solve problems involving conduction heat transfer with simple geometries through theoretical and experimental methods. (K3)

CO2: Apply the principles of free and forced convection heat transfer using empirical correlations and simple experiments. (K3)

CO3: Design a simple heat exchanger and evaluate its performance. (K3)

CO4: Apply the basic concepts of radiation heat transfer to thermal systems. (K3)

CO5:Apply the principles of diffusion and convective mass transfer for simple applications. (K3)

UNIT I CONDUCTION 18

General differential equation of heat conduction in various coordinate systems - One dimensional heat conduction for steady and unsteady state conditions - Extended surfaces - Case studies.

Experiments on determination of thermal conductivity of materials

UNIT IICONVECTION 18

Basic concepts - Boundary layer concept - Forced convection - External and internal flow - Free convection -External flow - Dimensional analysis - Applications.

Experiments on convective heat transfer: Forced convection & Natural convection inside a tube

UNIT IIIPHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS18

Nusselt theory of condensation - Pool and flow boiling - Heat exchangers - Types and working principle - Simple heat exchanger design - Fouling factors - Introduction to compact heat exchanger - Case studies.

Experiments on performance of heat exchangers: Parallel and Counter flow

UNIT IVRADIATION 18

Laws of radiation - Black body radiation - Grey body radiation - Shape factor algebra - Electrical analogy - Radiation shields - Introduction to gas radiation - Solar radiation - Concept and applications.

Experimental verification of Stefan Boltzman constant, Determination of emissivity of grey

surface

UNIT VMASS TRANSFER **18**

Basic concepts - Diffusion mass transfer - Steady state molecular diffusion - Convective mass transfer - Application of mass transfer: Cooling tower - Performance characteristics.

L:45 T:15 P:30; TOTAL:90 PERIODS

Note: (Use of HMT data book and steam tables are permitted in the end semester examination)

TEXT BOOKS

1. YunusCengel and Afshin Ghajar, "Heat and Mass Transfer: Fundamentals and Applications", McGraw-Hill Education, 2019, 6th Edition.
2. Frank P Incropera and David P DeWitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, 2018, 8thEdition.

REFERENCES

1. Nag PK, "Heat Transfer", Tata McGraw-Hill, New Delhi, 2011, 3rdEdition.
2. Sachdeva R C, "Fundamentals of Engineering Heat and Mass Transfer", New Age International, 2017, 5thEdition.
3. Holman JP, "Heat and Mass Transfer", McGraw-Hill Education, 2011, 10thEdition.
4. Ozisik MN, "Heat Transfer", McGraw-Hill Book Co., 1994.
5. Kothandaraman CP, "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2019.
6. NPTEL Lecture notes: https://nptel.ac.in/courses/112/108/112108149/
7. NPTEL videos: https://nptel.ac.in/courses/112/101/112101097/

19ME52C	DYNAMICS OF MACHINERY	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Analyze dynamic forces in the reciprocating engine, and predict mass and radius of gyration of flywheel using turning moment diagram. (K3)

CO2: Balance reciprocating and rotating masses in IC engines and identify whether the rotating system is balanced. (K3)

CO3: Predict the natural frequency of longitudinal and torsional vibration, and identify the critical speed of transverse vibration(K3)

CO4: Determine the amplitude of the forced vibration and force transmissibility. (K3)

CO5: Determine the characteristics of the mechanical governors, and analyze the effect of gyroscopic couple on automobiles, ships and aero plane. (K3)

UNIT I DYNAMIC FORCE ANALYSIS AND FLYWHEEL **12**

Introduction - Inertia force and inertia torque - D Alembert's principle - Dynamic force analysis in reciprocating engines - Gas forces - Inertia effect of connecting rod - Bearing loads - Crankshaft torque - Turning moment diagrams - Fly wheels - Flywheels of punching presses

UNIT II BALANCING OF MASSES 12

Static and dynamic balancing - Balancing of rotating masses - Balancing of single cylinder engine - Balancing of Multi-cylinder inline, V- engines - Partial balancing of reciprocating masses.

UNIT III FREE VIBRATION 12

Basic features of vibratory systems - Degrees of freedom - Single degree of freedom - Free vibration - Equations of motion - Natural frequency - Types of damping - Damped free vibration - Whirling of shafts -Torsional systems; Natural frequency of two and three rotor systems.

UNIT IV FORCED VIBRATION 12

Response of one-degree of freedom systems to periodic forcing - Harmonic disturbances - Disturbance caused by unbalance - Support motion - Transmissibility - Vibration isolation - Vibration measurement.

UNIT V MECHANISM FOR CONTROL: GOVERNORS AND GYROSCOPE 12

Governors - Types - Centrifugal governors - Watt, Porter and Proell - Spring loaded governors - Hartnell and Hartung governors - Characteristics - Effect of friction - Controlling force curves.

Gyroscopes - Gyroscopic forces and torques - Gyroscopic stabilization - Gyroscopic effects in automobiles, ships and airplanes

L:45; T:15; TOTAL:60 PERIODS

TEXT BOOKS

1. Rattan SS, “Theory of Machines”, 4th Edition, Tata Mc Graw Hill, New Delhi, 2017.
2. Thomas Bevan, “Theory of Machines”, 3rd Edition, Pearson India, 2009.

REFERENCES

1. Uicker JJ, Pennock GR and Shigley JE “Theory of Machines and Mechanisms”, 4thEdition, Oxford University Press, New Delhi, 2014.
2. Ballaney P L, “Theory of Machines and Mechanisms”, Khanna Publishers, New Delhi, 2005.
3. Ambedkar AG,” Mechanism and Machine Theory”, PHI Learning, New Delhi, 2009.
4. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.

19ME53C	DESIGN OF MACHINE ELEMENTS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the fundamental scientific principles of mechanical design and their use

in design analysis. (K2)

CO2: Design and analyze the shafts and couplings carrying various elements with geometrical features**.** (K3)

CO3: Design a suitable spring based on the requirements. (K3)

CO4: Design a suitable joint for a given application. (K3)

CO5: Design and select a sliding and rolling contact bearing based on the application. (K3)

UNIT I FUNDAMENTALS OF MACHINE DESIGN 12

Design considerations - Limits, fits and standardization - Selection of materials - Simple stress and strain relationship, types of stresses - combined stresses - Fatigue life - Factor of safety - theories of failure - Design based on strength and stiffness - Stress concentration - Design for variable loading.

UNIT II DESIGN OF SHAFTS AND COUPLINGS 12

Shafts and axles - Design of solid and hollow shafts based on strength, rigidity and critical speed - Keys and splines - Rigid and flexible couplings.

UNIT III DESIGN OF SPRINGS 12

Types of springs, design of helical and concentric springs - Surge in springs, Design of laminated springs - Spiral springs - Belleville spring

UNIT IV DESIGN OF JOINTS 12

Threaded fasteners - Bolted joints - Simple and eccentrically loaded bolted joints - Welded joints & symbols - Butt, fillet and parallel transverse fillet welds - Welded joints subjected to bending, torsional and eccentric loads - Riveted Joints - Design of knuckle and cotter joints.

UNIT V DESIGN OF BEARINGS 12

Theory of lubrication - Design of hydrodynamic bearings. Static and dynamic load capacity - probability of survival - Selection of rolling element bearing.

L:45; T:15; TOTAL:60 PERIODS

Note: (Use of P S G Design Data Book is permitted in the End Semester Examination)

TEXT BOOKS

1. Norton, R.L., Machine Design: An Integrated Approach, 2nd Edition, Pearson Education, 2013
2. Budynas, R.G. and Nisbett, J.K., Shigley‘s Mechanical Engineering Design, 9th Edition, Tata McGraw Hill Education, 2013.

REFERENCES

1. Bhandari V B, Design of Machine Elements, Tata McGraw Hill Education (India) Private Limited, New Delhi, 3rd Edition, 2010.
2. Schmid, S.R., Hamrock, B.J. and Jacobson B.O., Fundamentals of Machine Elements, 3rd Edition, CRC Press, 2014.
3. Kamlesh Purohit and Sharma CS, “Design of Machine Elements”, Prentice-Hall of

India Private Limited, New Delhi, 3rd Edition, 2005.
4. Wentzell Timothy H, "Machine Design; Machine Design, Delmar Cengage learning", U.S.A, 1st Edition, 2003.

19ME54C AUTOMATION IN MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand the importance of automation in the of field of manufacturing (K2)
CO2: Understand fundamentals of CAD, CAM, and CNC controls. (K2)
CO3: Discuss Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics based low-cost automations. (K2)
CO4: Discuss the product modeling, simulation and process routes. (K2)
CO5: Discuss the different configurations, programming techniques and applications of robots (K2)

UNIT I INTRODUCTION TO AUTOMATION 9

Introduction: Why automation, current trends, CAD, CAM, CIM; Rigid automation: Part handling, machine tools. Flexible automation: Computer control of machine tools and machining centers, NC and NC part programming, CNC - Adaptive control, Automated material handling - Assembly - Flexible fixture - Industry 4.0.

UNIT II FUNDAMENTALS OF CAD AND CAM 9

Computer aided design: Fundamentals of CAD - Hardware in CAD - Computer graphics software and data base - Geometric modeling for downstream applications and analysis methods - Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC adaptive control.

UNIT III LOW-COST AUTOMATION 9

Low-cost automation: Mechanical & Electro mechanical systems, Pneumatics and Hydraulics - Illustrative examples and case studies

UNIT IV MODELLING AND SIMULATION 9

Introduction to modeling and simulation: Product design, process route modeling - Optimization techniques - Case studies & industrial applications.

UNIT V INDUSTRIAL ROBOTICS 9

Introduction - Robot - laws of robot - Robot anatomy - Degrees of freedom, configurations - Work envelope - Specifications. Introduction to robot programming methods - Overview of programming languages - Robot applications in manufacturing, material transfer and machine loading/unloading, welding and painting, assembly operations, inspection, mobile robots - Flexible automation versus robotic technology.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, Pearson Education India; 4th Edition, 2016.

2. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2nd Edition, Tata McGraw-Hill Education, 2006.

REFERENCES

1. M. P. Groover, Principles of Modern Manufacturing, 5th Edition, Wiley, 2014.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, A press, 2017.
3. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th Edition, Pearson, 2013.
4. Groover, Industrial Robotics - Technology, Programming and Applications (Special Indian Edition), Tata McGraw-Hill Education, 2012

19ME55C	PROFESSIONAL ETHICS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Recognize the core human values and theories related to ethical behavior (K2)

CO2: Analyze the engineering ethical breach from case studies (K2)

UNIT I ETHICAL THEORIES AND HUMAN VALUES 8

Moral dilemmas and moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Vigil mechanism - Whistle blowing - Protected disclosures - Engineering as experimentation - Negligence - Codes of ethics - Personal ethics and human values - Governing Regulation.

UNIT II CASE STUDIES ON ETHICAL INFRINGEMENT 7

The challenger case study - The three-mile island and recent case studies. Intellectual Property Rights (IPR).

L:15; TOTAL:15 PERIODS

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 2017.
2. Govindarajan.M, Natarajan S and Senthil Kumar VS, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES

1. Charles D and Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint)
2. Charles E Harris, Michael S Protchard and Michael J Rabins, “Engineering Ethics - Concepts and Cases”, Wadsworth Thompson Learning, United States, 2018 (Indian Reprint now available)
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2016.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, 2001.

19ME56C	DYNAMICS LABORATORY	L	T	P	C
		0	0	2	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Calculate the mass moment of inertia of connecting rod and flywheel. (K3)

CO2: Balance rotating and reciprocating masses, and analyze the vibration before and after the balancing. (K4)

CO3: Predict and validate the natural frequency of the longitudinal, transverse and torsional vibratory systems, and investigate the vibration in the rotating machinery. (K4)

CO4. Determine the amplitude of forced vibrations. (K4)

CO5: Carry out performance study on governors, and analyze the effect of gyroscopic couple on motorized gyroscope model. (K4)

UNIT I MOMENT OF INERTIA 6

Moment of inertia - Flywheel and connecting rod - Dynamically equivalent system

UNIT II BALANCING OF MASSES 8

Balancing - Rotating masses and reciprocating masses

UNIT III VIBRATION MEASUREMENT AND ANALYSIS 8

Natural frequency - Time and Frequency domain analysis

UNIT IV CONTROL MECHANISMS 8

Governors - Sensitivity and effort - Gyroscope - Gyroscopic couple, Cam - Cam profile andJump phenomenon.

P:30; TOTAL:30 PERIODS

REFERENCES

1. Rattan SS, “Theory of Machines”, 4th Edition, Tata Mc Graw Hill, New Delhi, 2017.
2. Thomas Bevan, “Theory of Machines”, 3rd Edition, Pearson India, 2009.
3. Uicker JJ, Pennock GR and Shigley JE “Theory of Machines and Mechanisms”, 4thEdition, Oxford University Press, New Delhi, 2014.
4. Ballaney P L, “Theory of Machines and Mechanisms”, Khanna Publishers, New Delhi, 2005.
5. Ambedkar AG,” Mechanism and Machine Theory”, PHI Learning, New Delhi, 2009

19ME57C	COMPUTER AIDED DESIGN AND MANUFACTURING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1:Develop Part modeling, Assembly and detailing of practical engineering components. (K3)

CO2: Develop a Part model of existing physical component. (K3)

CO3: Develop a prototype using 3D printing. (K3)

CO4: Generate Cutter Location data using CAM software. (K3)

CO5: Perform simple operations in CNC Lathe and Milling machines. (K3)

UNIT I COMPUTER AIDED DESIGN 6

Part Modeling, Assembly and Detailing of Screw Jack, Flange Coupling, Knuckle Joint, Plummer Block

UNIT II REVERSE ENGINEERING 8

3D Modeling of physical components - Connecting Rod, Spur Gear, Piston - Image conversion using 3D scanner.

UNIT III ADDITIVE MANUFACTURING 8

Design and development of new product using Fusion Deposition Modeling.

UNIT IV COMPUTER AIDED MANUFACTURING 8

Numerical Control (NC) code generation using CAM software for milling and turning operations.

P:30; TOTAL:30 PERIODS

REFERENCES

1. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2nd Edition, Tata McGraw - Hill Education, 2006.
2. Donald Hearn, “Computer Graphics”- Pearson Education Ltd, 2nd Edition, 2008.
3. Vinesh Raja, Kiran J. Fernandes, Reverse Engineering: An Industrial Perspective, Springer Science & Business Media - 2007.
4. Otto, Kevin; Wood, Kristin, Product Design: Techniques in Reverse Engineering and New Product Development 1st Edition, Pearson, 2010.
5. G. Boothroyd, P. Dewhurst and W. A. Knight, Product Design for Manufacture and Assembly, 3rd Edition, CRC Press, 2010.

19ME61C METROLOGY AND MEASUREMENTS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon the completion of this course the students will be able to

CO1: Describe the concepts of measurements (K2)
CO2: Outline the principles of linear and angular measurement tools (K2)
CO3: Demonstrate the form measurement techniques (K2)
CO4: Explain the procedure for conducting computer aided inspection (K2)
CO5: Discuss various measuring techniques of power, flow and temperature (K2)

UNIT I BASICS OF METROLOGY 9

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – Their effect on precision and accuracy – Errors; Errors in measurements – Uncertainty in measurements – Types – Control – Types of standards.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear measuring instruments – Evolution – Types – Classification – Limit gauges – Gauge design – Terminology – Procedure – Concepts of interchange ability and selective assembly –Angular measuring instruments – Types – Bevel protractor, clinometers, angle gauges, spirit levels, sine bar – Angle alignment telescope – Autocollimator – Applications.

UNIT III ADVANCES IN METROLOGY 9

Basic concept of lasers - Advantages of lasers – Laser interferometers – Types – DC and AC laser interferometers – Applications – Straightness – Alignment. Basic concepts of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of machine vision system – Element – Applications.

UNIT IV FORM MEASUREMENT 9

Principles and methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, roundness measurement – Applications.

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 9

Measurement of force, torque, power - Mechanical, pneumatic, hydraulic and electrical type - Flow measurement: Venturi meter, orifice meter, rotameter, pitot tube – Temperature: Bi-metallic strip, thermocouples, electrical resistance thermometer – Reliability and calibration –Reproducibility and repeatability.

L:45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2018.
2. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2009.

REFERENCES

1. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.
2. Raghavendra, Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.
3. Donald Peckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
4. Alan S. Morris, “The essence of Measurement”, Prentice Hall of India 1996.
5. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th Edition, Cengage Learning EMEA, 1990.

19ME62C	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		2	1	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Design and select a flexible drive system for a given application. (K3)
CO2: Design and select a gear drive to transmit power between two parallel shafts.(K3)
CO3: Design and select a gear drive to transmit power between two non-parallel shafts. (K3)
CO4: Select a suitable ray diagram and construct the kinematic arrangement of gears to design multi speed gear box. (K3)
CO5: Select and design brakes, clutches and Power screws for appropriate applications. (K3)

UNIT I DESIGN OF FLEXIBLE TRANSMISSION SYSTEMS 9

Design of flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wireropes and pulleys – Design of transmission chains and sprockets.

UNIT II SPUR AND HELICAL GEARS 9

Speed ratios and number of teeth - Force analysis - Tooth stresses – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane - Equivalent number of teeth - Forces for helical gears.

UNIT III BEVEL AND WORM GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth.Estimating the dimensions of pair of straight bevel gears. Worm Gear: Terminology, Thermal capacity, materials - forces and stresses, efficiency, estimating the size of the worm gear pair.

UNIT IV GEAR BOXES 9

Gear box - Geometric progression, standard step ratio, Ray diagram, kinematics layout – Design of sliding mesh gear box - Constant mesh gear box.

UNIT V FRICTION DRIVES 9

Clutches - Introduction, Principle of operation of friction clutches, Clutch materials, friction lining materials, Types of clutches - Single plate clutches, Multi-plate clutches, Axial clutches, Cone clutches, Centrifugal clutches – Shoe or block brakes (single & double), internal and external shoe brakes, self-locking and self-energizing of brakes, simple and differential band brakes - Design of power screw - Square threads - Force analysis (for screw jack, lathe, etc.,)

L:30; T:15; TOTAL: 45 PERIODS

TEXT BOOKS

1. Robert L Norton, "Machine Deign" Pearson Education, 5th Edition, 2018
2. Bhandari V, "Design of Machine Elements", Tata McGraw-Hill Book Co, 4th Edition, 2016.

REFERENCES

1. Gitin M Maitra, Prasad L, "Handbook of Gear Design", Tata Mcgraw-Hill, 2011.
2. Prabhu T J, "Design of Transmission Systems", Private Publication, 5th Edition, 2018.
3. Richard Budynas, Keith Nisbett, "Mechanical Engineering Design", Mc-Graw Hill, 2011.
4. Spotts M F, Shoup T E, Hornberger L E, "Design of Machine Elements", Prentice Hall of India, 8th Edition, 2007.
5. William Orthwein, "Machine Component Design", Vol. I and II, Jaico Publishing house, New Edition, 2006.
6. IS 6938: Design of rope drum and chain hoists for hydraulic gates-Code of practice
7. IS 15146:2002 ISO 155:1998, Belt Drives- Pulleys-Limiting Values Adjustment of Centers.

19ME63C FINITE ELEMENT ANALYSIS

L	T	P	C
2	1	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss fundamental concepts of FEA and to solve mechanical engineering problems using suitable approximation method. (K3)

CO2: Solve structural problems using one dimensional element. (K3)

CO3: Select suitable two-dimensional elements to solve structural problems under plane stress and plane strain conditions. (K3)

CO4: Apply the concept of axisymmetric and dynamic analysis. (K3)

CO5: Formulate Isoparametric elements and model the problems in FEA (K3)

UNIT I FEA BASICS AND APPROXIMATION METHODS 9

Basic concepts of FEA - Engineering analysis - General procedure for FEA - Elasticity equations - Weighted residual method **-** Rayleigh Ritz method - Weak formulation method - Application to structural and heat transfer problems.

UNIT II ONE DIMENSIONAL FINITE ELEMENT ANALYSIS 9

Introduction - Finite element modeling, Coordinates - linear bar element, Truss and Beam

Elements - Interpolation function, Derivation of characteristic matrices. - Problems on structural and heat transfer analysis - Quadratic Bar element (Derivations only).

UNIT III TWO-DIMENSIONAL FINITE ELEMENT ANALYSIS 9

Dimensionality of a problem - Constant strain triangular element - Shape function, strain displacement, Stress calculations, temperature effects - Plane problems of elasticity - Problems in plane stress and plane strain - Application to solid mechanics and heat transfer problems.

UNIT IV AXISYMMETRIC ELEMENTS AND DYNAMIC ANALYSIS 9

Modeling techniques - use of symmetry, modeling of offsets, supports and joints. Axisymmetric formulation, Applications to cylinders under internal pressure and rotating disc- Types of dynamic analysis, general dynamic equation of motion, lumped and consistent mass matrices of bar and beam elements - Eigen value problem, Evaluation of eigenvalues and eigenvectors.

UNIT V ISOPARAMETRIC ELEMENT FORMULATION 9

Four noded rectangular element - Shape function, Strains and stresses - Need for Isoparametric formulation - four noded quadrilateral element - Numerical Integration, Application to structural problems – Usage of CAE software for different applications.

L:30; T:15; TOTAL: 45 PERIODS

TEXT BOOKS

1. Rao, S.S., The Finite Element Method in Engineering, 5th Ed., Elsevier Butterworth Heinemann, 2011.
2. Seshu P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2013.

REFERENCES

1. Bathe, K.-J., Finite Element Procedures, PHI Learning, New Delhi, 2010.
2. David V Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw-Hill Edition, 2017.
3. Cook, Robert D, Plesha, Michael E and Witt Robert J “Concepts and Applications of Finite Element Analysis”, Wiley Student Edition, 2012.
4. Reddy J N, “An Introduction to the Finite Element Method”, McGraw-Hill International Editions, 2009.

19ME64C PROJECT MANAGEMENT

L	T	P	C
1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain the concept of project management. (K2)

CO2: Apply the project monitoring techniques. (K2)

UNIT I PROJECT FORMULATION AND APPRAISAL 8

Introduction to project management – Project life cycle - Project selection and formulation –Investment decision analysis - Project appraisal – Break-even Analysis-Risk Analysis.

UNIT II PROJECT MONITORING AND CONTROL 7

Network techniques – CPM & PERT - project management teams and coordination - Monitoring and post implementation, evaluation of the project.

L:15; TOTAL: 15 PERIODS

TEXT BOOKS

1. Gobalakrishnan P and Ramamoorthy VE, "Textbook of Project Management", Macmillan Publications, 2014.
2. Maylor, "Project Management", 3rdEdition, Pearson, 2010.

REFERENCES

1. Gido, "Effective project management", 5thEdition, Cengage Learning, 2012.
2. Gray and Larson, "Project Management: The Managerial Process", 4thEdition, TMH, 2013.
3. Choudhury S, "Project Management", 1stEdition, Tata Mc Graw Hill Publishing Co., 2008.

19ME65C	**COMPREHENSION**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Recollect the knowledge acquired during the earlier semesters. (K2)

CO2: Apply fundamental principle of mechanical engineering concepts to solve real life problems. (K3)

CO3: Present technical topics and discuss about them. (K2)

CO4: Analyze and interpret experimental data with relevance. (K4)

UNIT I REVIEW OF TECHNICAL KNOWLEDGE 6

Review of various courses learned in the previous semesters by conducting objective type tests.

UNIT II PRESENTATION 6

A group of students present on any technical topic of their interest.

UNIT III ANALYSIS OF EXPERIMENTAL DATA 6

Analyzing and interpreting the results of experiments conducted in the earlier semester laboratory courses.

UNIT IV IDENTIFYING REAL LIFE PROBLEMS AND PROPOSING SOLUTIONS 6

Real life industrial problems which they may face in their work place will be analyzed and solutions will be formulated. At least one such problem will be identified and solved by

each group of students.

UNIT V REPORT WRITING 6

A thirty-page summary report should be submitted by each group of students for evaluation. The evaluation is based on continuous assessment by a group of Faculty Members constituted by the professor in-charge of the course.

L:30; TOTAL: 30 PERIODS

19ME66C	**METROLOGY AND AUTOMATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

COURSE OUTCOMES

Upon the completion of this course the students will be able to

CO1: Calibrate vernier, micrometer, slip gauges for inspection. (K3)

CO2: Measure the linear, angular, form and mechanical measurements. (K3)

CO3: Demonstrate the functioning of various pneumatic systems. (K4)

UNIT I LINEAR AND ANGULAR MEASUREMENT 10

Calibration and use of measuring instruments –Vernier caliper, micrometer, Vernier height gauge –using gauge blocks - Measurement of linear dimensions using Comparators - Measurement of angles using bevel protractor and sine bar

UNIT II FORM MEASUREMENT 10

Screw thread dimensions - Measurement of gear tooth parameters using gear tooth vernier caliper and profile projector - Measurement of straightness using Autocollimator - Measurement of temperature, Displacement and strain.

UNIT III PNEUMATIC CIRCUITS 10

Study of hydraulic, pneumatic and electro-pneumatic circuits - Operation of single and double acting pneumatic cylinder - Operation of double acting cylinder with quick exhaust valve - Operation of double acting cylinder in a cycle using limit switch and memory valve.

P:30; TOTAL:30 PERIODS

REFERENCES

1. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.
2. Raghavendra, Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013.
3. Donald Peckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
4. Alan S. Morris,“The essence of Measurement”, Prentice Hall of India 1996.
5. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th Edition, Cengage Learning EMEA, 1990.

19ME67C COMPUTER AIDED ANALYSIS LABORATORY L T P C

0 0 2 1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Analyze bar, beam and truss structure to determine deflection and stresses. (K3)

CO2: Conduct structural analysis on simple components. (K3)

CO3: Perform modal and harmonic analysis for structures. (K3)

CO4: Perform conductive and convective heat transfer analysis. (K3)

UNIT I ONE DIMENSIONAL STRUCTURAL ANALYSIS 8

Structural analysis of bars, beams and trusses.

UNIT II TWO- AND THREE-DIMENSIONAL STRUCTURAL ANALYSIS 8

Stress analysis of shaft, gear with hole, Stress analysis of pressure vessel and L bracket.

UNIT III VIBRATION ANALYSIS 7

Dynamic analysis of bar and beam for natural frequency and mode shape. Vibration analysis of 2D plate, Harmonic vibration analysis of simple beam.

UNIT IV THERMAL ANALYSIS 7

Thermal analysis- 1D and 2D with conduction and convection, Transient heat transfer analysis – Thermal stress analysis.

P:30; TOTAL: 30 PERIODS

REFERENCES

1. Saeed Moaveni, “Finite Element Analysis (Theory and application with ANSYS software)”, 4th Edition, Pearson Education Limited, 2015.
2. Paleti Srinivas, Krishna Chaitanya Sambana and Rajesh Kumar Datti, “Finite Element analysis Using ANSYS® 11.0”, PHI Learning Pvt. Ltd., 2010.
3. Nakasone Y, Yoshimoto S and Stolarski TA, “Engineering Analysis with ANSYS software”, Elsevier Butterworth-Heinemann, 2006.
4. Erdogan Madenci, Ibrahim Guven, “The Finite Element method and Applications in Engineering using ANSYS®”, Springer Publisher, 2006.

19ME68C PRODUCT DEVELOPMENT LABORATORY

L	T	P	C
1	0	2	2

Upon completion of this course, the students will be able to

CO1: recognize the needs of the customer and select concept to meet the requirements (K4)

CO2: verify the functionality of the concept through prototyping (K4)

UNIT I Need identification, target specifications and Concept Selection 20

Planning-customer need identification through empathy, problem definition, target specifications, concept development and selection.

UNIT II Prototyping and Demonstration 25

Prototyping: Low-fidelity and High-fidelity prototyping – Cost estimation – Product demonstration - documentation.

L:15;P: 30; TOTAL: 45 PERIODS

REFERENCE BOOKS

1. Michael G Luchs, Scott Swan, Abbie Griffin, “Design Thinking: New Product Development Essentials from the PDMA”, Willey, 2015
2. Christian Muller-Roterberg, “Design Thinking”, Wiley Publications, 2021
3. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata Mc Graw Hill Education, 4th Edition, 2011.
4. George E Dieter, Linda C Schmidt, “Engineering Design”, Mc-Graw Hill International Edition, 5thEdition, 2013.
5. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2013.

MENTOR ACTIVITIES

- Forming multidisciplinary/interdisciplinary batches among the students
- Facilitating the batches to define a problem through empathizing
- Guiding the batches to develop a prototype to verify the functionality of the concept
- Evaluating the students’ activities through demonstration and presentations

End semester Assessments can be made through:

- Product demonstration and presentation

Other points:

- This course is for all department students
- Course instructor and mentors will be responsible for the academic process.
- In a project batch, maximum number of students shall be limited to four
- Project batch may be interdisciplinary / multidisciplinary
- Multidisciplinary project batches are encouraged and permitted to take mentors from various discipline.

19ME71C	INDUSTRIAL ENGINEERING	L	T	P	C
		2	0	0	2

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the various production planning methodologies and layout design(K2)

CO2: carryout process planning and control to increase theproductivity. (K2)

CO3: suggest the effective work studyand ergonomics for better productivity. (K2)

CO4: handle the inventory management and suitable material handling equipment. (K2)

CO5: understand the concept of value engineering and plant maintenance. (K2)

UNIT I PRODUCTION SYSTEM **6**

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 good layout, Types of layout, Flow pattern,Work station design.

UNIT II PROCESS PLANNING AND PRODUCTION CONTROL **6**

Introduction to process planning - Definition, Procedure, Process selection, Machine capacity, process sheet, process analysis. Group technology –classification and coding system. Production planning, loading, scheduling. Production control-dispatching, routing - progress controlbar, curve, Ganttchart, routeand schedule chart.

UNIT III WORK STUDYAND ERGONOMICS **6**

Workstudy-Definition, Need, Advantages, method study and work measurement, Process chart symbols, outline process chart, flowprocesschart,multiple activity chart, flow diagram, string diagram, operation analysis, principles of motion economy, Therbligs, SIMO chart,stopwatchprocedure,micro&macromotionstudy,ergonomics-applications ofergonomic principlesinthe shopfloorwork benchesseatingarrangement, Industrialphysiology.

UNIT IV INVENTORY MANAGEMENT **6**

Inventory control, classification, management, objectives,functions. Economic order quantity, Economic batch quantity, inventory models, ABC analysis, Material Requirement Planning (MRP I), Manufacturing Resource Planning (MRP II), Operating cycle, KANBAN technique, lean manufacturing, Supply chain management-Material Handling Functions, Principles, Engineering and economic factors, Material handling equipment selection, maintenance,types.

UNIT V SYSTEM ANALYSIS AND MAINTENANCE **6**

System concept-system analysis, systems engineering, techniques and applications. Value analysis - Aim, technique, procedure, advantages, 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.

L:30; TOTAL:30 PERIODS

TEXT BOOKS

1. MartandT.Telsang, Industrial Engineering and Production Management, S Chand Publishers, 2018.
2. Ravi Shankar, Industrial Engineering and Management, GalgotiaPublications Pvt. Ltd., New Delhi, 2012.

REFERENCES

1. Jan Dul, Bernard Weerdmeester, Ergonomics for Beginners: A quick Reference Guide, CRC Press, TaylorandFrancis group, 2008.
2. Lee J.Krajewski, Larry P. Ritzman, Foundations of Operations Management, Addison Wesley, 2015.
3. PanneerselvamR., Production and operations management, Heritage Publishers, 2012.
4. Khanna O.P., Industrial Engineering and management, DhanpatRai Publications, 2012.

19ME72C	PROJECT WORK - I	L	T	P	C
		0	0	6	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: identify an innovate or creative idea / concept / solution to a problem (K3)
CO2: perform the detailed literature survey related to concept / idea (K2)
CO3: implement basic prototype to demonstrate the concept (K4)

1. The Project is a theoretical study/analysis / prototype design / modeling and simulation or a combination of these.
2. Should be done as group (preferably four students) project.
3. The progress of the project is evaluated based on a minimum three reviews and final viva-voce examination.
4. A project report is required to be submitted in the standard prescribed format.

P:90; TOTAL:90 PERIODS

19ME73C	RESEARCH PAPER AND PATENT REVIEW – SEMINARL		T	P	C
		0	0	2	1

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the emerging technology / research development in the engineering Field(K2)
CO2: acquaint with the concepts published in reputed journals on their area of interest(K2)

CO3: examine patents and procedures available in the data base.(K3)
CO4: effectively communicate the contents to the target audience and handle the questions with confidence(K3)
CO5: Check for patent plagiarism(K2)

The students will make a technical presentation on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of semester covering the various aspects of his/her presentation.

P:30; TOTAL:30 PERIODS

19ME74C INTERNSHIP / IN-PLANT TRAINING **L T P C**
0 0 4 2

COURSE OUTCOMES
Upon completion of this course, the students will be able to
CO1: acquire the knowledge of different industrial / organizational activities (K2)
CO2: document the work and communicate effectively through technical presentation (K2)

1. Student shall undergo internship/in-plant training after getting prior permission from the department
2. A report should be submitted after the successful completion of internship / in-plant training.

P: 60; TOTAL: 60 PERIODS

19ME81C	**PROJECT WORK - II**	**L**	**T**	**P**	**C**
		0	**0**	**12**	**6**

COURSE OUTCOMES
Upon completion of this course, the students will be able to
CO1: design and develop the working model (K3)
CO2: work independently to complete the project along with team members (K2)
CO3: demonstrate the results and documents the report (K4)

Project work shall be based on any of the following:
1. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
2. Experimental / Theoretical verification of principles used in the concept.
3. Projects having valid database, data flow, algorithm, and output reports, preferably software based.
4. Research findings, Recommendations and future scope.

P:180; TOTAL:180 PERIODS

B.E. – MECHANICAL ENGINEERING

OPEN ELECTIVE COURSES

Group – I (Basic Science Courses)

19ME01N APPLIED CHEMISTRY

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: gain knowledge on various purification and refining process in metallurgy (K1)
CO2: select proper engineering materials for desired engineering application (K2)
CO3: design an energy storage device by applying the basic concepts of batteries(K1)
CO4: synthesize the polymers used in day-to-day life (K1)
CO5: acquire knowledge on principle and applications of thermal analytical techniques. (K2)

UNIT I METALLURGY 9

Introduction - Various processes involved in extraction of metals – purification of metals – applications of redox reactions to extraction of elements from their ores: Ellingham diagrams. Secondary refining processes including AOD, VAD, VOD, VAR and ESR

UNIT II ENGINEERING MATERIALS 9

Refractories: classification and properties; Refractoriness, porosity, Dimensional stability – Lubricants: mechanism of lubrication – properties of lubricants – solid lubricants; Diamond and graphite – Abrasives: classification and uses.

UNIT III ENERGY RESOURCES AND STORAGE DEVICES 9

Nuclear energy fission and fusion reaction – nuclear reactor – solar energy conversion-solar cells wind energy – fuel cells. Hydrogen and oxygen fuel cell batteries alkaline batteries lead acid. Nickel cadmium and lithium batteries.

UNIT IV POLYMERS 9

Polymers: Types of Polymerization. Thermoplastics & thermosetting polymers. Preparation, properties and applications of the Polyethylene, Teflon, PVC, Nylon, Phenol formaldehyde & Urea Formaldehyde, Elastomers: Natural rubber, Vulcanization of rubber & Synthetic rubber.

UNIT V THERMOANALYTICAL METHODS 9

Thermo analytical methods - principle involved in differential thermal analysis - characteristics of TGA, DSC and DTA - thermo grams – factors affecting TGA and DTA curves - discussion of various components of the instrument with block diagrams - Applications of DT.

L:45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Jain P.C. and Monica Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010
2. Dara S.S. and Umare S.S., “A text book of Engineering Chemistry”, S.Chand and Company Limited, New Delhi, 2013.
3. Chawla.S, “A text book of Engineering Chemistry”, 16thEdition, Dhanpat Rai

Publishing Company, New Delhi, Reprint 2015.

REFERENCES

1. Lee, J. D., Concise Inorganic Chemistry, 5th Edition, Wiley-India, 2010
2. B.K. Sharma – "Industrial Chemistry", 1st Ed., Goel Publication, Meerut. 1983
3. V.R.Gowarikar, N.V. Viswanathan, Polymer science, Wiley Eastern Limited, New Delhi 1986.
4. Skoog D.A., James H. F. and Crouch S.R., "Instrumental Analysis", Cengage Learning India Private Limited, New Delhi, 2011.
5. F.W.Billmeyer, A Text book of Polymer Chemistry, John Wiley & sons, Singapore, 1994.

19ME02N	BIOPHYSICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: infer the basics of biophysics. (K2)
CO 2: interpret the structural aspects of proteins. (K2)
CO 3: interpret the structural aspects of nucleic acids. (K2)
CO 4: describe the significance of conformational aspects of Carbohydrates. (K2)
CO 5: summarize the different techniques in the investigation of biomolecules. (K2)

UNIT I BASICS OF BIOPHYSICS 9

Molecular alphabets of life (Amino acids, nucleic acid bases, saccharides and lipids) – Roles of biomolecules in biological functions – Geometry of biomolecules – Conformation and Configuration – Various bonds involved in structural stabilization of biomolecules.

UNIT II PROTEINS 9

Structure and properties of Amino acids - Structure and Conformations of proteins - Allowed conformations for a pair of linked peptide units – Ramachandran contact criteria and Ramachandran map – globular and fibrous proteins – Protein databases.

UNIT III NUCLEIC ACIDS 9

Base pairs - Nucleotides – Double helical structure of DNA, Watson and Crick model - base pairing and base stacking, Interactions stabilizing the structure of DNA – DNA polymorphism - A, B and Z forms – Structural elucidation of DNA.

UNIT IV CARBOHYDRATES 9

Monosaccharides, Disaccharides and Oligosaccharides – Structural and conformational aspects of some basic sugars. – Glycosidic torsional angles – Conformational map for typical disaccharides – Some significant polysaccharides and its applications - Carbohydrates as integral part of biological systems.

UNIT V BIOPHYSICAL METHODS 9

Basics of X-ray diffraction, X-ray Protein Crystallography, X-ray fibre diffraction. Structural investigation of Biomolecules by theoretical methods - Molecular Mechanics and Molecular Dynamics – Concepts- Visualization and graphical tools for different representation of Biomolecules.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Jack A.Tuszynski& Michal Kurzynski, "Introduction to Molecular Biophysics", 1st Edition, CRC press, 2003.
2. Reginald H. Garrett & Charles M. Grisham, "Biochemistry", 6th Edition, Cengage Learning Publishers, 2016.
3. Nathan R .Zaccai, Igor N .Serdyuk& Joseph Zaccai, "Methods in Molecular Biophysics", 2nd Edition, Cambridge University Press, 2017.

REFERENCES

1. VasanthaPattabhi& Gautham N, "Biophysics", 2nd Edition, Narosa Publishing House, 2011.
2. P. Narayanan, "Essentials of Biophysics", 1st Edition, Anshan Publishers, 2010.
3. David Whitford, "Proteins: Structure and Function", 1st Edition, John Wiley & Sons, 2013.
4. Jan Drenth, "Principles of Protein X-Ray Crystallography", 2nd Edition, Springer, 2013.

19ME03N	**CALCULUS AND STATISTICS FOR ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: Interpret the convergence of sequence and series (K2)
CO 2: Solve Bessel's and Legendre's equation (K2)
CO 3: Extremize the functional. (K3)
CO 4: Apply the concept of testing of hypothesis for small and large samples (K3)
CO 5: Apply the basic concepts of classifications of design of experiments (K3)

UNIT I SEQUENCES AND SERIES 9

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions

UNIT II POWER SERIES SOLUTIONS FOR DIFFERENTIAL EQUATIONS 9

Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties – Generating functions.

UNIT III CALCULUS OF VARIANTIONS 9

Concept of variation and its properties - Euler's equation - Functional dependent on first and higher order derivatives - Functional dependent on functions of several independent variables - Variational problems with moving boundaries - Ritz method.

UNIT IV TESTING OF HYPOTHESIS 9

Sampling distributions - Tests for single mean, Proportion, Difference of means (for large samples) – Tests for single variance and equality of variances – t-test, F-Test and Chi-square test for goodness of fit – Independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 9

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Srimanta Pal Subodh C. Bhunia " Engineering Mathematics" 1st Edition, Oxford Uuniversity press ,India , 2015
2. Grewal.B.S."Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2017.
3. Gupta, A.S., "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi,2004
4. Arnold O. Allen, "Probability, Statistic and Queueing Theory with Computer Science Applications", 2nd Edition, Elsevier a division of Reed Elsevier India Private limited, New Delhi, 2012
5. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2014.

REFERENCES

1. Johnson. R.A, Miller.I and Freund.J, Miller and Freund's Probability and Statistics for Engineers. Pearson Education, Asia, 8thsEdition, 2015.
2. Gary W. Oehlert, A First Course in Design and Analysis of Experiments, 1stEdition, W.H.Freeman and Company, 2010
3. Richard A. Johnson, Irwin Miller, John Freund, "Miller & Freund's Probability and Statistics for Engineers", Pearson Education Limited, Global Edition, 9thEdition, 2017.

19ME04N CORROSION SCIENCE AND ENGINEERING L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the thermodynamic and kinetic concept of corrosion. (K2)
CO2: describe the various forms of corrosion. (K2)
CO3: recognize the various corrosion testing techniques. (K2)
CO4: explain the various corrosion control methods. (K2)
CO5: describe the corrosion and its control methods of various industrial components (K2)

UNIT I THERMODYNAMICS AND KINETICS OF CORROSION 9

Need and importance - Causes - Corrosion of various metals and alloys in mineral acids, seawater, fresh water and high - purity water. Pourbaix diagrams, Electrode Kinetics Exchange Current Density, Activation Polarization, Concentration Polarization,

Combined Polarization, Mixed-Potential theory, Mixed Electrodes, Passivity, Mechanisms of the Growth and Breakdown of Passive Films.

UNIT II FORMS OF CORROSION 9

Uniform attack, Galvanic, Crevice, pitting, Intergranular, Erosion corrosion, Stress induced Corrosion– Bacterial corrosion – Marine corrosion - High temperature corrosion-Mechanism.

UNIT III CORROSION TESTING 9

Introduction - Weight loss method - Electrochemical methods - Warren test - NACE and slow strain rate test methods - Evaluating Pitting, crevice, galvanic, intergranular, exfoliation and stress corrosion.

UNIT IV CORROSION PROTECTION METHODS 9

Alloys - Anodic protection, Cathodic Protection, Inhibitors, Coatings: Organic coating, Metallic coating, Anodizing, phosphating, Chromate coating and control of Bacterial corrosion.

UNIT V CORROSION OF INDUSTRIAL COMPONENTS 9

Importance of corrosion prevention in various industries: The direct and indirect effects of corrosion - Corrosion and its control in Power industries, automotive industry, Chemical processing industries, marine industries and petroleum production and refining Industries

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Jain P.C. and Jain. M., “Engineering Chemistry”, 16thEdition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2013.
2. Dara S.S. and Umare S.S., “A text book of Engineering Chemistry”, S.Chand and Company Limited, New Delhi, 2013.
3. Chawla.S, “A text book of Engineering Chemistry”, 16thEdition, Dhanpat Rai Publishing Company, New Delhi, Reprint 2015.

REFERENCES

1. S. Sastri, E. Ghali, and M. Elboujdaini, Corrosion Prevention and Protection, Practical Solutions, Wiley, Chichester, England, 2007.
2. R. Winston Revie and Herbert H. UHLIG, Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering, 4th Edition-March 2008, John Wiley & Sons, Inc., publication ISBN: 978-0-471-73279-2,
3. BrankoN.Popov , Corrosion Engineering Principles and Solved Problems ISBN-13; 978-0-444-62722-3 Elsevier-2015
4. Zhaki Ahamed, Principles of Corrosion Engineering and corrosion control, First Edition 2008, Elsevier, ISBN-13-978-0-7506-5924-6
5. Mars G.Fontana, Corrosion Engineering, Third Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi. ISBN-13;978-0-07-060744-6
6. Volkan Cicek Corrosion Engineering Scrivener Publishing LLV and John Wiley & Sons, Inc., publication 2014 ISBN-978-1-118-72089-9

7. Philip A.Schweitzer, P.E. Corrosion Engineering Hand Book,Marcel Dekker, Inc., New York,1996, ISBN -0-8247-9709-4

19ME05N	POLYMER SCIENCE AND TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the basic concept of polymer, the importance of polymers in various fields,and differentiate the different types of polymers based on its function. (K2)

CO2: Acquire the knowledge to impart special properties to the polymer by modifying the structural features of polymers. (K2)

CO3: Identify the various polymer processing techniques which relate directly to the material(s) used in its construction (K2)

CO4: familiar with the various analytical methods to determine the physical and chemical properties of polymers. (K2)

CO5: familiar with the applications polymers in various fields. (K2)

UNIT I INTRODUCTION 9

Introduction-Monomers, functionality, degree of polymerizations-classification of polymers- glass transition-melting transition-criteria for rubberiness-polymerization methods: addition and condensation; metallocene polymers and other newer techniques of polymerization- copolymerization, monomer reactivity ratios and its significance-kinetics-different copolymers: random, alternating, azeotropic copolymerization, block and graft copolymers- techniques for copolymerization-bulk, solution, suspension, emulsion.

UNIT II STRUCTURE PROPERTY RELATIONSHIP 9

General structural features of polymers: Effects of atoms -types of bonds-bond dissociation energy-functional groups on properties of polymers. Polymer chain flexibility: concept-various factors for deciding flexibility- properties of polymers affected by flexibility - Intermolecular orders: Amorphous-crystalline and oriented forms of polymers-crystallinity in polymers-factors affecting crystallinity-properties affected by the crystallinity of polymers.

UNIT III POLYMER PROCESSING TECHNIQUES 9

Type of reactors: batch reactors-tubular flow reactors- stirred tank reactors. Processing Techniques: Basic of processing techniques -One-dimensional process (Coating and Adhesives)-Compression molding-transfer molding-injection molding-blow molding-reaction injection molding-extrusion-pultrusion-calendaring-rotational molding-thermoforming-rubber processing in two-roll mill-internal mixer.

UNIT IV MOLECULAR CHARACTERIZATION OF POLYMERS 9

Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance.

Analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA) and microscopic (optical and electronic) techniques.

UNIT V APPLICATION OF POLYMERS 9

Technical applications: thermoplastics (PVC, PVA)-thermostats (PF, UF), and elastomers (SBR, GR-N)-silicones. Application of polymers in space, ocean, electronics, medical, agriculture, automobile, sports, and building construction. Special Polymers: Fire retardant polymers- Biodegradable polymers-electroluminescent polymers.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubber, Blends and Composites, McGraw Hill Education; 3rd Edition, 2017.
2. Richard A Petherick, Polymer Science and Technology for Engineers and Scientists, Whittles Publishing, 2010.

REFERENCES

1. Anil Kumar, Rakesh K. Gupta, Fundamentals of Polymer Engineering, Revised and Expanded, CRC Press,2003
2. Fred W. Billmayer, Textbook of Polymer Science, John & Wiley inc., 1984
3. Alfred Rudin, Philip Choi, The Elements of Polymer Science and Engineering, 3rd Edition, Academic press publications, Elsevier, 2013.

19ME06N	LASER TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the basic concepts of lasers. (K2)
CO2: learn the surface treatment process by laserK2)
CO3: describe the cutting, welding and drilling processes using laser (K2)
CO4: explain the micro machining processes by laser (K2)
CO5: gain knowledge about holography and medical applications of lasers (K2)

UNIT I BASIC PRINCIPLE OF LASER AND ITS TYPES 9

Characteristics of laser -Spontaneous and Stimulated Emission process and Einstein's coefficients-Population inversion-Pumping-meta-stable state- wave length chart types of laser- three & four level lasers, Continuous Wave Lasers, Pulsed lasers, Q-switch lasers Solid state lasers: Nd-YAG laser-Liquid lasers: Dye laser, Gas laser: Argon ion laser-Krypton ion laser

UNIT II LASER SURFACE TREATMENT 9

Introduction –forms of laser surface treatment-laser transformation hardening - advantages - laser surface melting - laser alloying - laser cladding-co-axial powder feeding lateral powder feeding-laser texturing-case examples

UNIT III LASER WELDING CUTTING AND DRILLING 9

Laser welding -process arrangement - mechanisms - applications –modes of welding-conduction limited welding-key hole welding-heat flow theory - one dimensional heat flow - Laser cutting –process characteristics-theoretical models of cutting - practical performance applications –process variation- drilling –single pulse drilling-percussion drilling-trepanning applications.

UNIT IV MICROMACHINING AND LASER SAFETY 9

Fiber Laser and UV Laser based marking - micromachining solutions - laser shock loading - basics - applications - laser safety - danger - safety limits - eye and skin - class four safety arrangements - electric hazards - fume hazards.

UNIT V HOLOGRAM AND MEDICAL APPLICATIONS 9

Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non-destructive testing – Holographic components – Medical Science: Medical lasers, Laser diagnostic, Laser in ophthalmology, Laser for general surgery, Laser in dermatology, laser in dentistry- laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynecology and oncology.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. William M. Steen, “Laser Material Processing”, Springer Verlag, 2003
2. K.Thyagarajan, AjoyK.Ghatak, “Lasers, Theory and Applications”, Plenum Press, 1981.

REFERENCES

1. Svelto, “Principles of lasers” 5th Edition, Springer International publishing, 2010
2. Paulo Ribeiro, Maria Raposo, “Optics, Photonics and Laser Technology”, Springer International publishing, 1st Edition, 2018
3. Uday Shanker Dixit, Shrikrishna N. Joshi, J. Paulo Davim, “Application of Lasers in Manufacturing” Springer Singapore, 1st Edition, 2019
4. Stephan Wieneke and Christoph Gerhard, “Lasers in Medical Diagnosis and Therapy Basics, applications and future prospects” IOP Publishing Ltd, 2018
5. AK Katiyar, CK Pandey and Manisha Bajpai, “Fundamentals of Laser Systems and Applications”, Wiley, 2017.

19ME07N	**FUNDAMENTALS OF NANO SCIENCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the fundamentals of nanoscience (K2)
CO2: recognize the different methods of synthesizing nanomaterials (K2)
CO3: identify the exact characterization technique to analyze different properties (K2)
CO4: describe the different properties of nanomaterials(K2)

CO5: explain the various applications of nanomaterials in different fields (K2)

UNIT I BASIC CONCEPTS OF NANOSCIENCE 9

Introduction of nanomaterials - History of nanomaterials - Size effect of Nanomaterials: Size, shape, density, melting point, wet ability and specific surface area - Surface to Volume Ratio – Energy at the Nanoscale - Quantum Confinement Effects –Nanosized metals, alloys, semiconductors, ceramics – classification based on the dimensionality: nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, nanotubes, quantum wells, metal based nanostructures, nanocomposites, carbon nanotubes

UNIT II SYNTHESIS OF NANOMATERIALS 9

Bottom-up, Top-down Approach - Inert gas condensation, Plasma arc technique, Ion sputtering, Laser ablation, Ball Milling, Molecular beam epitaxy (MBE), Chemical vapour deposition (CVD) method, Ultrasonication, Chemical precipitation and co-precipitation, Sol-Gel synthesis; Microemulsions synthesis, Hydrothermal, Solvothermal synthesis methods, Microwave assisted synthesis.

UNIT III CHARACTERIZATION TECHNIQUES 9

X-ray diffraction (XRD), SEM, EDAX, AFM, TEM, Elemental mapping, FTIR, UV-Visiblespectrophotometer, Laser Raman Spectroscopy, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), X-ray Photoelectron Spectroscopy (XPS), Electrochemcial Characterization measurements, Nanoindentation.

UNIT IV PROPERTIES OF NANOSTRUCTURED MATERIALS 9

Mechanical behaviour: Modes of Deformation - Elastic and Plastic Deformation - Mechanical Stiffness - tensile strength- Fracture - Toughness - Superplasticity - Hardness -Micro-hardness - wear resistance and corrosion resistance behaviour - Hall-Petch Relation - Fundamentals of Nanomechanics and Nanotribology - Thermal properties: Thermal conductivity, thermal expansion and thermal expansion coefficient - Electrical properties: Electrical conductivity, band gap tuning, band gap determination - Magnetic properties: Magnetic hysteresis - Superparamagnetism - Optical properties of nanostructures.

UNIT V APPLICATIONS OF NANOMATERIALS 9

Functional graphene- carbon nanotube and polymer composite applications in defence and aerospace. Nanomaterials for solar Cells- Nanoscale catalysts for energy and automobile industries. Rechargeable batteries based on nanomaterials- Nanomaterials for electrodes and wearable electronics- Nano based coating and paints.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Nanostructures & Nanomaterials: Synthesis, Properties &Applications, G. Cao, Imperial College Press, 2004.
2. Fundamentals of Nanotechnology, Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep, CRC Press, 2009

REFERENCES

1. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag, 2004.
2. Impedance spectroscopy: Theory, Experiment and applications, E. Barsoukov, J. R. McDonald, John Wiley & Sons Ltd, 2000.
3. Nanostructures and nanomaterials: Synthesis, properties and applications, G. Cao, Imperial College Press, 2006.

19ME08N BIOLOGY FOR MECHANICAL ENGINEERS L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: describe the concepts of mechano biology. (K2)
CO2: acquire the knowledge on biomechanics (K2)
CO3: understanding the fabrication process of various Bioenergy sources (K2)
CO4: illustrate the various bio engineering process (K2)
CO5: know the various biomaterials and its applications produce (K2)

UNIT I MECHANOBIOLOGY 9

Introduction - Need to study - Mechanobiology of Stem Cell-Mechanobiology of Diseases-Mechanical Forces & DNA damage-Techniques in Mechanobiology

UNIT II BIOMECHANICS 9

Introduction - Fluidics in living systems - Pressure driven flows - Surface tension driven flows – Mechanics of joints – Structure – types – Biomechanical analysis of elbow, shoulder, spine and knee

UNIT III BIO-INSPIRED ENGINEERING 9

Introduction to biologically-inspired designs (BID for Biomedical and Non-biomedical applications): Human-organs-on-chips; Bio-optics; Nanostructures for Drug Delivery; Artificial neural networks; Biosensors: role in medical diagnostics; Bio-filters; Bio-robotics; 3D Bio-printing

UNIT IV BIO MATERIALS 9

Introduction – requirements – biocompatibility materials – Alloys - Titanium alloys, Stainless steel, Co-Cr-Mo alloys, Magnesium alloys - Ceramics – Properties – Applications of Joints: Skeletal joints, skeletal muscles, the elbow shoulder, Spinal column, hip, knee and ankle.

UNIT V BIOENERGY 9

Introduction – Microbial fuel cell – beneath fuel cell- Characterization -Biomass resources - Biogas production- Bioenergy distribution and end use for a sustainable future

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Y.Nelson, L.David, Lehninger Principles of Biochemistry, 7th Edition, International Edition. New York: W. H. Freeman, Macmillan Learning, 2017.
2. S.ThyagaRajan., N.Selvamurugan. M.P.Rajesh. R.A.Nazeer, W.Richard, S.Thilagaraj, Barathi, and Jaganathan.M.K, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.
3. Bioenergy: Principles and Applications by Yebo Li and Samir Kumar Khanal,1st Edition, 2016
4. Gefen, Amit, Cellular and biomolecular mechanics and mechanobiology, Springer, 2010

REFERENCES

1. J. L. Tymoczko, J. M. Berg and L. Stryer, Biochemistry, 7th Edition, W. H. Freeman & Co, 2012.
2. Jonathan Black, "Biological Performance of Materials: Fundamentals of Biocompatibility" Fourth Edition: CRC Taylor & Francis Group, London, 2006.
3. Judy D. Wall and Caroline S. Harwood, Bioenergy, 1st Edition, 2008
4. Christopher. R. Jacobs,Introduction to Cell mechanics and Mechanobiology, Garland Science, 1st Edition, 2012

19ME09N	INTRODUCTION TO ROBOTICS	L	T	P	C
		3	1	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the fundamentals of robot's configurations for the design (K2).
CO2: Identify a suitable gripper and sensor system of the robot (K3).
CO3: Select suitable on drive systems for various actuations of robot (K3).
CO4: Develop robot programs for the specific applications (K3).
CO5: Design the Unmanned Aerial Vehicle with fixed wing, multi-copter and flapping wing (K3).

UNIT I INTRODUCTION TO ROBOTICS 12

Introduction - Automation – Robotics - Brief History, Basic Concepts of Robotics such as Definition, Three laws, Elements of Robotic Systems, i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems based on various parameters such as work volume, type of drive, etc., Associated parameters, i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Industrial applications of the robot.

UNIT II GRIPPERS AND SENSORS FOR ROBOTICS 12

Grippers for Robotics - Types of Grippers, guidelines for the robotic gripper, Force analysis for various basic gripper systems. ***Sensors for Robots*** - Need for sensors- Types of Sensors used in Robotics, Classification and Selections of sensors, applications of sensors. The vision system of a robot.

UNIT III DRIVES AND CONTROL FOR ROBOTICS 12

Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. ***Control Systems***: Types of Controllers, Introduction to closed-loop control.

UNIT IV PROGRAMMING AND LANGUAGES FOR ROBOTICS 12

Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, ***Programming Languages***: Generations of Robotic Languages, Introduction to various types such as VAL, RAIL, AML, Python, ROS etc., - case studies.

UNIT V UNMANNED AERIAL VEHICLE 12

Unmanned Aerial Vehicle (UAV) - Taxonomy –Need –definition- applications- Remote sensing, Aerial mapping, Disaster response, Surveillance Search and rescue, Transportation Payload delivery.

Development strategy of Fixed wing UAVs - Multi-copter UAV- Flapping wing UAV- Swarm Robot - case study.

L:45; T:15; TOTAL:60 PERIODS

TEXT BOOKS

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education, 2014.
2. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press, 2006.
3. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2019.

REFERENCES

1. R. K. Mittal, I. J. Nagrath, Robotics and Control, Tata McGraw Hill Publishing CoLtd, New Delhi, 2003.
2. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., 2020.
3. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer, 1997.
4. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) Pvt Ltd, 2012.
5. R.D.Klafter, Thomas A.Chmielewski, and MechaelNegin, Robotic Engineering – An Integrated Approach, EEE, Prentice Hall India, Pearson Education Inc, 2009.

Group – II (Engineering Science Courses of other discipline)

19ME11N	TESTING AND CALIBRATION OF INSTRUMENTS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explain key terms related to testing and calibration. (K2)
CO2: illustrate the test measurement instrumentation system. (K2)
CO3: explain the testing procedures for industrial instruments. (K2)
CO4: summarize the procedures related to calibration requirements. (K2)
CO5: explain the calibration services of different laboratories. (K2)

UNIT I INTRODUCTION TO TESTING AND CALIBRATION 9

The Signal Flow of Electronic Instruments, The Instrument Block Diagram, Measurement Systems, Types of instruments, Traceability, Calibration Types, Calibration Requirements, Calibration Methodology, Instrument Specifications and Calibration Tests, Calibration Standard Requirements.

UNIT II INSTRUMENTATION AND DATA ANALYSIS 9

Test Measurement Instrumentation, Process Instrumentation, Test Objective - Requirements and limitations, Test Data - Format and Analysis.

UNIT III TESTING OF INSTRUMENTS 9

Voltage-Voltmeter, Current - Ammeter and Resistance - Ohmmeter, Temperature - Thermocouple, Pressure - Primary pressure sensing elements-Diaphragm, Bourdon tube**. Flow – Pitot tube, Anemometer.**

UNIT IV CALIBRATION REQUIREMENTS 9

Calibration procedure, calibration procedure content, calibration datasheet, Instrument Specification Forms, Project Specifications, Manufacturer's Specifications, Calibration Intervals, Safety Considerations, Calibration Status Labels.

UNIT V CALIBRATION STANDARDS 9

National Measurement Standard Laboratories, Commercial Calibration Services, **Standards in different National Laboratories and Bureaus**, calibration management and maintenance.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mike Cable, "Calibration - A technician's guide", ISA, 2005.
2. Vaisala Oyj, "Calibration Book", Calibration book project team, 2006.

REFERENCES

1. Clyde F.Coombs Jr, "Electronic Instrument Handbook", Tata McH, 3rd Edition, 2008.
2. M/s. Beamex OYED, Fram in Vaasa, Finland, 2nd Edition, 2012.
3. Tony R. Kuphaldt, "Lesson in Industrial Instrumentation", 2017.

19ME12N	DIGITAL ELECTRONICS FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the binary number system and codes. (K2)
CO2: simplify the Boolean expression using K map reduction techniques. (K3)
CO3: analyse and design combinational circuits. (K3)
CO4: analyse and design basic sequential circuits. (K2)
CO5: design and implement digital logic using memories. (K2)

UNIT I BINARY SYSTEMS 9

Introduction of Digital Computers and Digital Systems, Binary numbers, Base Conversion (BINARY, DECIMAL, HEX, OCTAL), R's Complement, (R-1)'s Complement, Binary Codes.

UNIT II BINARY LOGIC AND BOOLEAN ALGEBRA 9

Basic Binary logic, Basic and Universal logic gates, Boolean theorems and algebra, Postulates, De-Morgan's Theorems, SOP and POS forms, Canonical form, Boolean Function Implementation. Simplification using Boolean algebra, Karnaugh map - 2 – Variable, 3 – Variable, 4 – variable using Don't care condition.

UNIT III COMBINATIONAL CIRCUITS 9

Basic Combinational circuit, Design procedure of combinational logic, Adder - Half Adder, Full Adder, Subtractor, Half Subtractor-Full Subtractor, Code Conversion-BCD – Excess-3 conversion, Decoder, Encoder, Multiplexer, Demultiplexers.

UNIT IV SEQUENTIAL CIRCUITS 9

Sequential Circuits – Latches and types of Flip Flops, Shift Registers types and universal shift register – Counters -up counter, down counter and up down counter, Johnson counter, ring counter, ripple counter.

UNIT V MEMORY AND PROGRAMMABLE LOGIC DEVICES 9

Memories: RAM – SRAM, DRAM and ROM – Programmable Logic Array - Programmable Array Logic.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Morris Mano M. and Michael D. Ciletti, Digital Design, 5th Edition, Pearson Education, 2013.
2. Charles H. Roth Jr, Fundamentals of Logic Design, 5th Edition, Jaico Publishing House, Mumbai, 2003.

REFERENCES

1. John F. Wakerly, Digital Design Principles and Practices, 4th Edition, Pearson Education, 2007.
2. Kharate G. K., Digital Electronics, Oxford University Press, 2010.
3. R.P.Jain, "Modern Digital Electronics", TMH, 2nd Edition, 2013.

19ME13N	INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explain the principles of measurements and its standard (K2)
CO2: describe the working principle of level, flow, and temperature measurement techniques (K2)
CO3: describe the working principle of force, speed and vibrational measurement techniques (K2)
CO4: develop a mathematical model for a mechanical system (K3)
CO5: design the control strategy for electro-mechanical system (K3)

UNIT I CONCEPTS OF MEASUREMENT SYSTEM 9

Measurement Fundamentals: The process of measurement- calibration, significance, generalized measuring system, Characteristics of measuring instruments: Static characteristics - Precision, Accuracy, Sensitivity, Repeatability, Reproducibility, Linearity, Errors- Systematic and Random, Uncertainty of Measurement,

Measurement Standards: National, Reference, Secondary, and Working Standards, interchangeability, Bias, Calibration, calibration of machine tools Traceability, Confidence level.

UNIT II LEVEL, FLOW AND TEMPERATURE MEASUREMENT 9

Measurement of Level: Direct methods - Indirect methods - Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators – Bubbler level indicators.

Flow measurement: Turbine Meters, Electromagnetic Flowmeters, Rotameter, Magnetic, Ultrasonic, Turbine flowmeter, Hot - wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Temperature: Bimetallic strip, liquid in glass thermometer, Resistance Temperature Detectors (RTD), Thermistor, Thermocouples, Pyrometers.

UNIT III FORCE, SPEED AND VIBRATION MEASUREMENT 9

Measurement of Force: Strain gauge factor, mechanical strain gauge, electrical strain gauge, platform balance, load cell - Temperature compensation techniques, use of strain gauges for measuring torque, strain gauge rosettes.

Measurement of Speed: Mechanical Tachometers, Electrical tachometers, Non - contact type Stroboscope.

Measurement of Acceleration and Vibration: Different simple instruments - Principles of Seismic instruments – Vibrometer and accelerometer principle- piezo electric accelerometer.

UNIT IV MODELING AND RESPONSE OF MECHANICAL SYSTEM 9

Mathematical modelling of electrical, mechanical, and electromechanical system, spur and gear mechanism – servomechanism - time response of first order and second order mechanical system.

UNIT V CONTROL SYSTEM PRINCIPLE 9

Basic elements of control systems – open loop and closed loop control – elements of closed loop control system - concept of stability, Introduction to ratio, split range, feedforward, and cruise control. Overview of P, PI and PID controllers.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Beckwith T G and Buck N L, "Mechanical Measurements", 6th Edition, Pearson Education, 2013.
2. Ogata Katsuhiko, "Modern Control Engineering", Prentice Hall International, 5thEdition, New Delhi, 2010

REFERENCES

1. Jain RK, "Mechanical and Industrial Measurements", Khanna Publishers, Delhi, 1999
2. Rangan, Mani and Sharma, "Instrumentation", Tata McGraw Hill Publishers, New Delhi, 2004
3. Alan S Morris, "Measurement and Instrumentation Principles", Butterworth, 2006.
4. Sawhney A.K, "A Course in Mechanical Measurements and Instrumentation", 12thEdition, Dhanpat Rai & Co., 2001.
5. Nagrath I J, Gopal M, "Control Systems Engineering", 6th Edition, New Age International Pvt. Ltd., New Delhi, 2018.

19ME14N	MICROPROCESSOR, MICROCONTROLLER AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explain the architecture and functional blocks of 8085 processor. (K2)
CO2: develop simple programs with 8085 processor. (K3)
CO3: explain the architecture and functional blocks of the 8051 microcontroller. (K2)
CO4: interface the peripherals with 8085 and 8051. (K3)
CO5: develop simple applications by programming with 8051 microcontroller. (K2)

UNIT I 8085 PROCESSOR 9

Hardware Architecture, Pinouts – Functional Building Blocks of Processor – Memoryorganization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.

UNIT II PROGRAMMING OF 8085 PROCESSOR 9

Hardware Architecture, Pinouts – Functional Building Blocks of Processor – Memoryorganization – I/O ports and data transfer concepts– Timing Diagram – Interrupts-DataTransfer, Manipulation, Control Algorithms& I/O instructions, Comparison to Programming
concepts with 8085.

UNIT III 8051 MICRO CONTROLLER 9

Voltage-Voltmeter, Current - Ammeter and Resistance - Ohmmeter, Temperature -

Thermocouple, Pressure - Primary pressure sensing elements-Diaphragm, Bourdon tube.

UNIT IV PERIPHERAL INTERFACING 9

Architecture, configuration and interfacing, with ICs: 8255, 8259, 8254, 8279, – A/D and D/A converters &Interfacing with 8085& 8051.

UNIT V MICRO CONTROLLER PROGRAMMING & APPLICATIONS 9

Simple programming exercises- key board and display interface –Control of servo motor stepper, motor control- Application to automation systems.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. R.S. Gaonkar, Microprocessor Architecture Programming and Application, with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. Sunil Mathur &Jeebananda Panda, Microprocessor and Microcontrollers, PHI Learning Pvt. Ltd, 2016.

REFERENCES

1. Krishna Kant, Microprocessor and Microcontrollers, Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.
2. B.RAM, Computer Fundamentals Architecture and Organization New Age International Private Limited, Fifth Edition, 2017.
3. Soumitra Kumar Mandal, Microprocessor and Microcontroller Architecture, Programming and Interfacing using 8085, 8086, 8051, McGraw Hill Edu, 2013.
4. Ajay V.Deshmukh, Microcontroller Theory &Applications, McGraw Hill Edu, 2016.
5. Douglas V.Hall, Microprocessor and Interfacing, McGraw Hill Edu, 2016.

19ME15N ELECTRICAL DRIVES AND CONTROL

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the basic concepts of different types of electrical machines and their performance. (K2)

CO2: Recall the characteristics and different methods of starting D.C motors and induction motors. (K2)

CO3: Explain the operation of conventional and solid-state DC drives. (K2)

CO4: Discuss the concepts of conventional and solid-state AC drives. (K2)

CO5: Describe the working principles of stepper motor and servo motor drives. (K2)

UNIT I INTRODUCTION 9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions – Industrial drives- types, group drive, individual drive, multi motor drive - Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

UNIT II DRIVE MOTOR CHARACTERISTICS AND STARTING METHODS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – Types of D.C Motor starters – Three phase squirrel cage and slip ring induction motor starters.

UNIT III D.C. DRIVES (qualitative treatment only) **9**

Speed control of DC series and shunt motors – Armature and field control, Ward- Leonard control system - Using controlled rectifiers and DC choppers – applications.

UNIT IV A.C. DRIVES (qualitative treatment only) **9**

Induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – using inverters and AC voltage regulators – applications.

UNIT V STEPPER MOTOR AND SERVO MOTOR DRIVES 9
(Qualitative treatment only)

PMDC, Stepper motor- construction and working principle and applications – Servo motor – types: brushless servo motor, permanent magnet servo motor construction and applications, stepper motor drive: single stepping and half stepping. Servo drives.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. G. K. Dubey, “Fundamentals of Electrical Drives”, 2nd Edition, Narosa Publishing house, New Delhi, 2019 Reprint.
2. Nagrath.I.J. &Kothari.D.P, “Electrical Machines”, Tata McGraw-Hill, New Delhi, 2006.

REFERENCES

1. Pillai.S.K “A first course on Electric drives”, Wiley Eastern Limited, 2012.
2. M.D.Singh, K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2008.
3. VedamSubrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw-Hill, 2011.

19ME16N FOUNDATIONS OF MACHINE LEARNING

L	T	P	C
2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the basics and application of Machine learning (K2)
CO2: Explain data analyzing techniques (K2)
CO3: Apply data exploration and data preparation techniques (K3)
CO4: Apply data visualization techniques (K3)
CO5: Apply regression for solving practical problems (K3)

UNIT I INTRODUCTION 12

Types of machine learning: Supervised learning- Unsupervised Learning - Reinforcement Learning- Applications of Machine Learning

UNIT II DATA ANALYSIS 12

Quality and Transformation- Getting to Know the Data: Normal Distribution-Identifying Data Quality Issues: Missing Values, Irregular cardinality, Outliers-Handling Data Quality Issues: Handling Missing Values, Handling Outliers

UNIT III DATA EXPLORATION AND DATA PREPARATION 12

Visualising Relationships Between Features, Measuring Covariance and Correlation, Measure of Distribution (Skewness and Kurtosis) -Data Preparation: Normalisation-binning-sampling

UNIT IV DESCRIPTIVE STATISTICS AND DATA VISUALIZATION 12

Descriptive Statistics for Continuous Features: Central Tendency, Variation- Descriptive Statistics for Categorical Features- Populations and Samples- Data Visualization: Bar Plots, Histograms, Box Plots, Bubble charts, Tree map, Heat map, Motion charts

UNIT V REGRESSION 12

Regression –Gradient descent- Linear Regression –Multivariate Regression regularized regression – Evaluating and Validating Models –Cross-Validation

L:30; P:30 TOTAL:60 PERIODS

TEXT BOOK

1. John D Kelleher, Brain Mac Namee and Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics", MIT Press, 2015

REFERENCES

1. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge university Press, 2020.
2. Bruce Ratner, "Statistical and Machine-Learning Data Mining", CRC press, 2017.
3. Peters Morgan, "Data Analysis from Scratch with Python", AI Sciences, 2016

19ME17N	MECHANICS OF ROBOTS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply fundamental mathematical model for the mechanics of robotics. (K3)

CO2: Derive mathematical expression for the manipulator positioning and motions(K3)

CO3: Analyze basics of motion programming as per kinematics. (K3)

CO4: Formulate mathematical expression for robot dynamics. (K3)

CO5: Develop the robot programs to control the movements of robot manipulate. (K3)

UNIT I MATHEMATICS FOR MECHANICS OF ROBOTICS 9

Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.

UNIT II ROBOT KINEMATICS 9

Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.

UNIT III STATICS AND ROBOT LINKAGE 9

Velocities & Statics: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, Jacobian Jv/Jw, Jacobian in a Frame, Jacobian in Frame, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy, Mechanical Design of robot linkages

UNIT IV ROBOT DYNAMICS 9

Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution, Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration.

UNIT V ROBOT PROGRAMMING 9

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

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education, 2014.
2. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, 2019.

REFERENCES

1. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press, 2006.
2. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, 2005.
3. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison Wesley2003.

Group – III (Computational Skills)

19ME21N	COMPUTER GRAPHICS AND VIRTUAL REALITY	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: apply different view of projections on objects (K3)
CO 2: apply 2D and 3D transformations (K3)
CO 3: apply lighting and shading effects on objects (K2)
CO 4: explore 3D interaction techniques (K2)
CO 5: work on virtual reality tools (K3)

UNIT I INTRODUCTION TO COMPUTER GRAPHICS 12

Graphics system and models: Applications of Computer Graphics, Graphics System, Physical and Synthetic Images, Imaging Systems, Graphics Architectures – Primitives and Attributes, Color, Control functions, Adding Interaction. Viewing: Positioning of the Camera, Parallel Projections, Perspective Projections, OpenGL Projection Matrices.

UNIT II GEOMETRIC OBJECTS AND TRANSFORMATIONS 12

Scalars, Points and Vectors, Three-Dimensional Primitives, Coordinate Systems and Frames, Frames in OpenGL, Matrix and Vector Classes, Modeling a Colored Cube, Affine Transformations – Translation, Rotation and Scaling, Transformations in Homogeneous Coordinates, Concatenation of Transformations, Transformation Matrices in OpenGL, Interfaces to Three-Dimensional Applications, Quaternion- 2D transformations: Translation, Scaling, Rotation, and Shearing – 3D transformations: Translation, Scaling, and Rotation.

UNIT III FRAGMENTATION, LIGHTING AND SHADING 12

Vertices to Fragments: Basic Implementation Strategies, Four Major Tasks, Clipping– Line Clipping, Polygon Clipping, Clipping of Other Primitives, Clipping in Three Dimensions, Polygon Rasterization, Hidden-Surface Removal, Antialiasing, Display Considerations. Lighting and Shading: Light and Matter, Light Sources, Polygonal Shading, Specifying Lighting Parameters, Global Illumination.

UNIT IV 3D INTERACTION TECHNIQUES 12

3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines – 3D Travel Tasks, Travel Techniques. Design Guidelines – System Control, Classification, Graphical Menus, Voice Commands, Gestural Commands, Tools, Multimodal System Control Techniques, Design Guidelines – Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques.

UNIT V ADVANCES IN 3D USER INTERFACES 12

3D User Interfaces for the Real World, AR Interfaces as 3D Data Browsers, 3D Augmented Reality Interfaces, Augmented Surfaces and Tangible Interfaces – Agents in AR, Transitional AR-VR Interfaces - The future of 3D User Interfaces, 3D Interaction Techniques- 3D UI Design and Development-3D UI Evaluation and Other Issues.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Edward Angel, "Interactive Computer Graphics: A Top-Down Approach Using OpenGL", 7th Edition, Addison-Wesley, 2015.
2. Hearn Baker Carithers, "Computer Graphics with Open GL", 4th Edition, Pearson Education Limited 2014.
3. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.

REFERENCES

1. Abdulmotaleb El Saddik , Mauricio Orozco, Mohamad Eid, Jongeun Cha, "Haptics Technologies: Bringing Touch to Multimedia", Springer; 2011.
2. https://booksite.elsevier.com/samplechapters/9780123749437/01~Front_Matter.pdf
3. http://cmp.felk.cvut.cz/cmp/courses/XE33PVR/WS20072008/Lectures/Technical/intro-print.pdf
4. https://virsabi.com/everything-about-haptic-technology
5. Virtual Reality for Enhanced Computer Vision (http://staff.fhhagenberg.at/burger/publications/pdf/ifip-portugal94.pdf)

19ME22N	MOBILE APPLICATION DEVELOPMENT	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Work in the mobile application development framework and understand the life cycle of mobile application (K2).
CO2: understand the Android platform and its components (K2)
CO3: work on mobile application tools to create simple applications (K3)
CO4: understand Android views, view Groups and layouts. (K2)
CO5:Understand about intents and services in android application development (K2).

UNIT I INTRODUCTION 12

Mobile Applications - Characteristics and Benefits - Application Model - Infrastructure and Managing Resources - Mobile Software Engineering - Frameworks and Tools - Mobile devices Profiles.

UNIT II INTRODUCING ANDROID 12

The Android platform - Understanding the Android market - The layers of Android - Four kinds of Android components - Understanding the AndroidManifest.xml file - Mapping applications to processes.

UNIT III TOOLS 12

Android Platform - Eclipse Emulator - Android Application Architecture - Event based programming - iOS Platform - UI tool kit interfaces - Event handling and Graphics services - Layer Animation.

UNIT IV ANDROID STUDIO DEVELOPMENT ENVIRONMENT 12

Setting up an Android Studio Development Environment - Creating an Example Android App in Android Studio - Creating an Android Virtual Device (AVD) in Android Studio - The Basics of the Android Studio Code Editor - Saving and Restoring the State of an Android Activity - Understanding Android Views, View Groups and Layouts.

UNIT V APPLICATION DEVELOPMENT 12

Intents and Services - Storing and Retrieving data - Communication via the Web - Notification and Alarms - Graphics and Multimedia - Location based services - Packaging and Deployment - Security and Hacking.

L:30; P:30; TOTAL:60 PERIODS

REFERENCES

1. W. Frank Ableson, Robisen, Chris King, C. Enrique Ortiz, “Android in Action” Third Edition - Manning Shelter Island, 2012.
2. ZigurdMednieks, Laird Dornin, G.BlakeMeike and Masumi Nakamura, “Programming Android”, O Reilly, 2011.
3. Reto Meier, “Professional Android 2 Application Development”, Wrox Wiley, 2010.
4. Alasdair Allan, “iPhone Programming”, O‟Reilly, 2010.
5. Wei-Meng Lee, “Beginning iPhone SDK Progrmming with Objective-C”, Wrox Wiley, 2010.
6. Poslad, “Ubiquitous Computing: Smart Devices, Environments and Interactions”, Wiley, 2009.

19ME23N	OBJECT ORIENTED PROGRAMMING	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: identify the differences of structured and object-oriented programming features. (K3)

CO2: develop programs using overloading and appropriate constructors. (K3)

CO3: develop the applications using appropriate inheritance and polymorphism mechanisms (K3)

CO4: use advance features like templates and exception to make programs supporting reusability and sophistication. (K3)

CO5: Implement rich data handling through files and STL. (K3)

UNIT I BASIC CONCEPTS 12

Introduction to OOPs - Applications of OOP - Structure of C++ - Program - C++ Basics: Keywords - Constants - Data Types - Dynamic Initialization of Variables - Reference Variables - Operators in C++ - C++ Class Overview: Class Definition Objects - Class Members - Access Control - Scope Resolution operator - Friend Functions - static class members.

UNIT II CONSTRUCTORS AND OVERLOADING 12

Constructors, Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic initialization of Objects, Copy Constructors, Dynamic Constructors, Destructors - Function Overloading - Operator overloading, Rules for Operator overloading - overloading of binary and unary operators.

UNIT III INHERITANCE AND POLYMORPHISM 12

Introduction to inheritance - Defining Derived Classes - Single Inheritance - Multiple Inheritance - Multi-Level Inheritance - Hierarchical Inheritance - Hybrid Inheritance - Virtual Base Classes - Abstract Classes - Constructors in Derived Classes - Introduction to pointers - Pointers to Objects - Virtual Functions - Pure Virtual Functions - Virtual Destructors.

UNIT IV TEMPLATES AND EXCEPTION HANDLING 12

Introduction - Class Templates - Class Templates with Multiple Parameters - Function Templates, Function Templates with Multiple Parameters - Member Function Templates - Basics of Exception Handling, Types of exceptions - Exception Handing Mechanism - Throwing and Catching Mechanism.

UNIT V FILE HANDLING AND STL 12

Files in C++: File handling in C++ - File I/O - Formatted and Unformatted I/O - STL.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Herbert Schildt, “C++: The Complete Reference”, 5th Edition, Tata McGraw - Hill Publishers, 2014.
2. Paul Deitel, Harvey Deitel, “C++ How to Program”, 8th Edition, Prentice Hall Publisher, 2016.
3. Trivedi, Bhushan “Programming with ANSI C++”, 2nd Edition, Oxford University Press - NASW Press, 2013.

REFERENCES

1. Ira Pohl, “Object Oriented Programming using C++”, 2nd Edition, Pearson Education, Reprint 2004.
2. S. B. Lippman, Josee Lajoie, Barbara E. Moo, “C++ Primer”, 4th Edition, Pearson Education, 2012.
3. Bjarne Stroustrup, “The C++ Programming language”, 4th Edition, Pearson Education, 2013.

19ME24N	PROGRAMMING IN PYTHON	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: develop simple Python programs. (K3)

CO2: structure simple Python programs for solving problems and decompose a Python program into functions. (K3)
CO3: represent compound data using Python lists, tuples, and dictionaries. (K3)
CO4: understand file management concepts and develop packages in Python Programs. (K3)
CO5: design and Develop GUI Programming. (K5)

UNIT I DATA, EXPRESSIONS, STATEMENTS 12

Python interpreter and interactive mode - values and data types: Variables - expressions - statements - Operators - precedence of operators - Input and Output - comments - Errors: Syntax Errors - Runtime errors - Logical Errors.

UNIT II CONTROL FLOW, FUNCTIONS 12

Conditionals: Boolean values and operators - conditional (if) - alternative (if-else) - chained conditional (if-elif-else) - Iteration: state - while - for - break - continue - pass - Fruitful functions: Function argument and its types - return values - parameters - local and global scope - function composition - recursion.

UNIT III LISTS, TUPLES, DICTIONARIES 12

Strings: string slices - immutability - string functions and methods - string module - Lists: list operations - list slices - list methods - list loop - mutability - aliasing - cloning lists - list Parameters - Lists as arrays - Tuples: tuple assignment - tuple as return value - Dictionaries: operations and methods.

UNIT IV FILES, MODULES, INTERPRETERS & PACKAGES 12

Files and exception: text files - reading and writing files - format operator - command line arguments - errors and exceptions - handling exceptions - modules - Computer Numerical Controller (CNC) implementation using python - CNC G codes to stepper Motor - Python control of Linux CNC for prototyping machine- packages - Name space.

UNIT V GRAPHICAL USER INTERFACE PROGRAMMING 12

Event driven programming - TkInter introduction - Introducing callbacks - User input - Simple case study: Graphics: Moving the ball - Adding randomness - Keyboard input - Checking for collisions - Keeping score.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, O'Reilly Media, Inc., 2016.
2. Brian Heinold, “A Practical Introduction to Python Programming”, Mount St. Mary’s University, 2012.
3. Richard L. Halterman, “Learning to Program with Python”, 2019, E-book.
4. Mark Pilgrim, “Dive into Python”, Apress, 2012.

REFERENCES

1. Timothy A.Budd, “Exploring Python”,, Mc-Graw Hill Education (India) Limited, 2015.
2. PaulGries, Jennifer Campbell and Jason Montojo, “Practical Programming: An Introduction to Computer Science using Python 3.6”, Pragmatic Programmers, LLC, 2018.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd, 2016.
4. http://ce.sharif.edu/courses/96-97/2/ce153-6/resources/root/Learn-to-Program-with-Python.pdf.

19ME25N FUNDAMENTALS OF JAVA PROGRAMMING

L	T	P	C
2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: apply object-oriented concepts to solve real world problems (K3)
CO 2: explain the principles of packages and strings in java. (K2)
CO 3: develop multi-thread applications with exception handling (K3)
CO 4: create user interfaces for java application and applets using GUI (K3)
CO 5: build real time applications with JDBC and Collections (K3)

UNIT I JAVA BASICS **12**

OOPS Concepts-Java Programming Constructs - Objects and Classes - Methods - Constructors - Access Specifiers - Data Types - Variables - Operators - Control Statements - Arrays - Inheritance - Method Overriding - Abstract Class - Interfaces.

UNIT II PACKAGES AND STRING **12**

Packages - Importing Packages - Access Protection -Wrapper Classes - String Handling - Character extraction - string comparison - Methods for Modifying and Searching String.

UNIT III EXCEPTION HANDLING AND THREADS **12**

Exception Handling: Try, Catch, Finally Blocks - Throw - Throws - Class Throwable- Multithreaded Programming: Creating Threads - Creating Multiple Threads - Thread Priorities - Synchronization - Inter Thread Communication - Suspending, Resuming and Stopping of Threads.

UNIT IV APPLETS AND EVENT HANDLING **12**

Applet Basics - Applet Architecture - Applet Class and Methods - Passing parameters to Applets - Event Handling - Delegation Event Model - Event Classes - Event Listener Interfaces - Adapter Classes.

UNIT V JDBC AND COLLECTIONS **12**

The Design of JDBC - The Structured Query Language - JDBC Configuration - Executing SQL - Collections: Wrapper classes - Collection framework.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Hortsmann& Cornell, "CORE JAVA 2 Advanced Features - VOL-II", Pearson Education, 10th Edition, 2017.
2. Deitel H M and Deitel P I, "Java - How to Program", Pearson Education, New Delhi, 11th Edition, 2017.
3. Herbert Schildt, Java: The Complete Reference, 11th Edition, 2018.

REFERENCES

1. Anita Seth, B.L.Juneja, "JAVA one step ahead", Oxford University Press Publication,Second Edition,2018.
2. Sachin Malhotra and Saurabh Choudhary, "Programming in Java", Oxford University, New Delhi, 2018.
3. Herbert Schildt, "Java: A Beginner's Guide", Tata McGraw Hill, 2007.

19ME26N	**PROGRAMMING FOR ROBOTICS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: interpret the basic concepts of Robot programming. (K2)
CO 2: enrich the robot programming through VAL. (K3)
CO 3: develop robot with movement and motion instructions. (K3)
CO4: understand the importance of operating and data processing. (K3)
CO 5: explore the interfacing tools and testing of robot. (K3)

UNIT I INTRODUCTION TO ROBOT PROGRAMMING 12

Introduction - Types - Flex Pendant - Lead through programming, Coordinate systems of Robot, Robot controller - major components, functions - Wrist Mechanism - Interpolation - Interlock commands Operating mode of robot, Jogging - Types, Robot specifications - Motion commands, end effectors and sensors commands.

UNIT II ROBOT PROGRAMMING LANGUAGES 12

Robot Languages - Classifications, Structures, Variable Assembly Language (VAL) - VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program - WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT III RAPID LANGUAGE 12

RAPID language basic commands - Motion Instructions-Pick and place operation using

Industrial robot - manual mode, automatic mode, subroutine command-based programming. Move master command language-Introduction, syntax, simple problems.

UNIT IV AML LANGUAGE 12

ARC Macro Language (AML): AML Language - General description, elements and functions, Statements, constants and variables - Program control statements - Operating systems, Motion, Sensor commands - Data processing.

UNIT V PRACTICAL STUDY OF VIRTUAL ROBOT 12

Robot cycle time analysis - Multiple robot and machine Interference - Process Chart - Simple Problems - Virtual robotics, Robot studio online software - Introduction, Jogging, components, work planning, program modules, input and output signals - Singularities - Collision Detection - Repeatability measurement of robot - Robot economics.

L:30; P:30; TOTAL:60 PERIODS

REFERENCES

1. S.R.Deb, “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 2010.
2. Mikell. P. Groover, “Industrial Robotics Technology, Programming and Applications”, McGraw Hill Co, 2008.
3. RobotIcs Lab manual, 2007.
4. Klafter. R. D, Chmielewski. T. A. and Noggin’s., “Robot Engineering: An Integrated Approach”, Prentice Hall of India Pvt. Ltd., 2011.
5. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 2008.
6. Craig. J. J. “Introduction to Robotics mechanics and control”, Addison-Wesley, 2018.

19ME27N FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE

L	T	P	C
2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand intelligent agents for search and games (K2)
CO2: Solve AI problems through programming with Python. (K3)
CO3: Learning optimization and inference algorithms for model learning. (K2)
CO4: Design and develop programs for an agent to learn and act in a structured environment. (K3)
CO5: Design some of the applications that use Artificial Intelligence (K3)

UNIT I INTRODUCTION 12

Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Basic terminologies of tree and graph structures, State space representation, Search graph and Search tree.

UNIT II SEARCH ALGORITHMS 12

Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A* algorithm, Game Search.

UNIT III PROBABILISTIC REASONING 12

Probability, conditional probability, Bayes Rule, Bayesian Networks - representation, construction and inference, temporal model, hidden Markov model.

UNIT IV MARKOV DESIGN PROCESS 12

MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

UNIT V LEARNING 12

Supervised and Unsupervised learning, Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning - Q learning.

L:30; P:30; TOTAL:60 PERIODS

LIST OF PRACTICALS (Should be given as Assignments)

1. Write a programme to conduct uninformed and informed search.
2. Write a programme to conduct game search.
3. Write a programme to construct a Bayesian network from given data.
4. Write a programme to infer from the Bayesian network.
5. Write a programme to run value and policy iteration in a grid world.
6. Write a programme to do reinforcement learning in a grid world.
7. Mini Project work

TEXT BOOK

1. S.Russel, P.Norvig, “Artificial Intelligence - A Modern Approach”, 3rdEdition, Pearson Education, 2015.

REFERENCES

1. Elaine Rich and Kevin Knight, “Artificial Intelligence”, 3rd Edition Tata McGraw-Hill Education Pvt. Ltd, 2008.
2. Trivedi, M.C., “A Classical Approach to Artificial Intelligence”, Khanna Publishing House, 2018.
3. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning India, 2011

19ME28N MODELLING AND SIMULATION

L	T	P	C
2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the basics of simulation and modelling. (K2)

CO2: generate random numbers and random variates using different techniques. (K3)

CO3: develop simulation model using heuristic methods. (K3)

CO4: identify the relevant input and output analyzer, verification and validation models and simulation software. (K3)

CO5: simulate the models for the purpose of optimum control by using software. (K3)

UNIT I INTRODUCTION 12

Introduction to Simulation: Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System.

UNIT II RANDOM NUMBERS GENERATION 12

General Principles: Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling. Random Numbers: Properties, Generations methods, Tests for Random Number - Frequency test, Runs test, Autocorrelation test.

UNIT III SIMULATION MODEL USING HEURISTIC METHODS 12

Random Variate Generation: Inverse Transform Technique - Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods - Erlang distribution.

UNIT IV SIMULATION MODELS USING INPUT AND OUTPUT ANALYZER 12

Analysis of Simulation Data Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model - Model Building, Verification, Calibration and Validation of Models.

UNIT V FUZZY AND GA 12

Modeling Based on Expert Knowledge - Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers. Simulation of Engineering Systems: Monte-Carlo simulation. Genetic Algorithm - operations - elitism.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOK

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2nd Edition. Academic press 2000.

REFERENCES

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, Discrete Event system Simulation, Pearson Education, Asia, 4th Edition, 2007, ISBN: 81-203-2832-9.
2. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4.
3. Ogata K "Modern control Engineering" 3rd Edition. Prentice hall of India 2001.
4. Jang J.S.R. sun C.T and Mizutani E, "Neuro-Fuzzy and soft Computing ", 3rd Edition, Prentice Hall of India 2002.

5. Shannon, R. E., “System Simulation: The Art and Science”, Prentice Hall Inc. 1990.
6. Pratab.R , "Getting started with MATLAB" Oxford university Press, 2009.
7. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill International Editions -Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.
8. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004, ISBN: 0-87692-028-8.

19ME29N	ESSENTIALS OF MACHINE LEARNING	L	T	P	C
		2	0	2	3

Course Outcomes

Upon completion of this course, the students will be able to

CO 1: Explain the features of Machine learning technique (K2)

CO 2: Apply the Artificial Neural Network for solving practical problems (K3)

CO 3: Provide solution for clustering problems in real-world applications.(K3)

CO 4: Apply Support Vector Machines and Decision Tree for solving practical problems (K3)

CO 5: Apply Naive Bayes Classifier and K-Nearest Neighbors for solving practical problems (K3)

UNIT I INTRODUCTION **12**

Machine Learning Process-Terminologies: Weight Space, Curse of Dimensionality, Overfitting, Training, Testing, Validation Sets-Performance Measures: Confusion Matrix, Measurement Precision- Model selection Validation Techniques- Feature Reduction/Dimensionality reduction- Principal components analysis.

UNIT II ARTIFICIAL NEURAL NETWORK (ANN) **12**

ANN basics-Feed-forward Network – Training Algorithms- Transfer functions - Network Training – BackPropagation-Testing and Validation.

UNIT III CLUSTERING **12**

Distance measures- Different clustering methods (Distance, Density, Hierarchical)- Iterative distance-based clustering - Dealing with continuous, categorical values in K-Means-Constructing a hierarchical cluster - K-Medoids.

UNIT IV SUPPORT VECTOR MACHINES AND DECISION TREE **12**

Support Vector Machines: Linear learning machines and Kernel space, Making Kernels and working in feature space - SVM for classification and regression problems.

Decision Trees: C4.5- Ensemble’s methods: Random forest.

UNIT V NAIVE BAYES CLASSIFIER AND K-NEAREST NEIGHBORS **12**

Naive Bayes Classifier: Model Assumptions, Probability estimation- Required data processing- M-estimates, Feature selection: Mutual information - Classifier - K-Nearest Neighbors: Computational geometry; Voronoi Diagrams; Delaunay Triangulations - K-Nearest Neighbor algorithm.

L:30; P:30 TOTAL:60 PERIODS

REFERENCES

1. Flach, “Machine Learning: The art and science of algorithms that make sense of data”, Cambridge University Press, 2012.
2. Chris Albon “Machine Learning with Python Cookbook”, O’Reilly Media, 2018
3. Wei-Meng Lee, “Python Machine Learning”, John Wiley & Sons, 2019.
4. John Paul Mueller, and Luca Massaron, “Machine Learning”, John Wiley & Sons, 2016
5. Andreas C. Müller and Sarah Guido, “Introduction to Machine Learning with Python-A Guide for Data Scientists”, O’Reilly publications, First Edition, 2016.

19ME30N	MICROPROCESSOR AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	1	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: configure the embedded systems for a specific application.(K3)
CO2: select the robotic control-hardware based on specific need (K3)
CO3: utilize the embedded processor architecture for robot control system(K3)
CO4: apply the concept of CAN protocol communication (K3)
CO5: develop codes for interfacing the various input and outputs devices through embedded programming. (K3)

UNIT I INTRODUCTION 12

Definition: Embedded system, Intelligent System, Expert system, software architecture, hardware architecture –Block diagram of embedded systems- Trends in Embedded Industry- Basic Embedded System Models - Embedded System development cycle- Challenges for Embedded System Design - Embedded System design flow selection considering any three different Applications.

UNIT II ROBOTIC CONTROL-HARDWARE 12

Robot anatomy: links, Joints and end effectors - Position sensors: Potentiometer, LVDT, Halleffect sensors-Interfacing of Quadrature encoder with controller-Torque sensor and its interfacing scheme-Proximity sensor (Ultrasonic) and its interfacing scheme-Range finder (light based) and its interfacing scheme

UNIT III ARM -32 BIT MICROCONTROLLER 12

ARM processor family variants- Architecture of ARM Cortex M3 –functional block diagram of LPC1768 - General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Register. Nested Vector Interrupt Controller. Interrupt behavior of ARM Cortex M3-Internal logic blocks with associated registers- Debug Architecture. Embedded Firmware Design Approaches.

UNIT IV CONTROLLER AREA NETWORK (CAN) 12

History and foundation of CAN, CAN Applications, Main characteristics of CAN, CAN in OSI Reference Model, CAN Data Link Layer, Principles of data exchange in CAN, Arbitration, Data Frame, Remote Frame, Error detection and management in CAN, CAN physical Layer, Bit encoding, Bit timing and synchronization, Relationship between data rate and bus length, Single wire and twin wire media, CAN repeaters, Medium-to-medium gateway, Protocol handlers, Micro-controllers and line drivers, Time Triggered CAN (TTCAN), CAN based applications development

UNIT V EMBEDDED SYSTEM INTERFACING PROGRAMS PRACTICE: 12

1. PWM – LED Interfacing
2. Switches – BuzzerInterfacing
3. Motor Interface: servo motor and steppermotor
4. LCD DisplayInterfacing
5. Distance Measurement using HCSR 04Sensor.
6. Temperature measurement using DHT11sensor
7. Pressure measurement using BMP280sensor
8. Analog sensor interfacing using LM35D andADC080
9. Onboard web server for ExternalCommunication
10. CANCommunication

L:45; P:15; TOTAL: 60 PERIODS

TEXT BOOKS

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, Newness, 2008.
2. James K Peckol, “Embedded Systems – A contemporary Design Tool”, John Wiley Edition, 2008.
3. K. V. Shibu, Introduction to Embedded Systems, McGraw Hill Publications, 2009.

REFERENCES

1. Gilbert Held. “Inter- and Intra-Vehicle Communications, CRC Press2007
2. Marco Di Natale, “Understanding and using controller area network communication protocol”, Springer2008
3. Saeed B. Niku, “Introduction to robotics: Analysis, Control and Applications”, Wiley student edition, 2009.

Group – IV (Management Skills)

19ME31N	ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain the types, characteristics of entrepreneurship and its role in economic development. (K2)

CO2: Discuss the theories of achievement motivation and the principles of entrepreneurship development program. (K2)

CO3: Select the appropriate form of business ownership in setting up an enterprise. (K2)

CO4: Demonstrate the fundamental concepts of finance and accounting to enterprise. (K2)

CO5: Identify sickness in industry, select the appropriate corrective measures, and identify the growth strategies in enterprise. (K2)

UNIT I INTRODUCTION 9

Entrepreneur – Characteristics – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur – Role of Entrepreneurship in Economic Development – Factors Affecting Entrepreneurial Growth – Economic, Non-Economic, Government Actions.

UNIT II MOTIVATION 9

Entrepreneurial Motivation: Theories and Factors, Achievement Motivation –Entrepreneurial Competencies – Entrepreneurship Development Programs – Need, Objectives – Business Game, Thematic Apperception Test, Self Rating, Stress management.

UNIT III BUSINESS 9

Small Enterprises – Definition, Characteristics, Project Identification and selection – Project Formulation: Significance, content, formulation of project report – Project Appraisal: Concept and method – Ownership Structures: Selection & Pattern.

UNIT IV FINANCE AND ACCOUNTING 9

Finance: Need, Sources, Capital Structure, Term Loans – Accounting: Need, Objectives, Process, Journal, Ledger, Trial Balance, Final Accounts – Working Capital Management: Significance, Assessment, Factors, Sources, Management.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business: Concept, Signals, Symptoms, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in Small Scale Enterprise – Institutional Support to Entrepreneurs: Need and Support – Taxation Benefits to Small Scale Industry: Need, Depreciation, Rehabilitation, Investment.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. S.S.Khanka, “Entrepreneurial Development” S.Chand& Co. Ltd. Ram Nagar New Delhi, revised edition, 2013.

2. Kuratko & Hodgetts, "Entrepreneurship – Theory, process and practices", Thomson learning 9th Edition, 2014
3. Vasant Desai, "The Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 6th Edition, 2018.

REFERENCES

1. Charantimath, P. M., Entrepreneurship Development and Small Business Enterprises, Pearson, 2nd Edition, 2013.
2. Hisrich R D and Peters M P, "Entrepreneurship" 8th Edition Tata McGraw-Hill, 2013.
3. Rajeev Roy, "Entrepreneurship", Oxford University Press, 2nd Edition, 2011.

19ME32N	HUMAN RESOURCE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the importance human resource management perspective (K2)
CO2: Outline the current theory and practice of recruitment and selection. (K2)
CO3: Describe appropriate implementation, monitoring and assessment procedures of training (K2)
CO4: Discuss the significance of employee benefits to both employers and employees (K2)
CO5: Explain the importance of the performance management system in enhancing employee performance (K2)

UNIT I PERCEPTIVE IN HUMAN RESOURCE MANAGEMENT 9

Evolution of human resource management – the importance of the human factor – objectives of human resource management – role of human resource manager – human resource policies – computer applications in human resource management.

UNIT II HUMAN RESOURCE PLANNING AND RECRUITMENT 9

Importance of Human Resource Planning – Forecasting human resource requirement – Skill matrix - matching supply and demand - Internal and External sources- Organizational Attraction-. Recruitment, Selection, Induction and Socialization- Theories, Methods and Process.

UNIT III TRAINING AND DEVELOPMENT 9

Types of training methods purpose benefits resistance - Executive development programmes – common practices - benefits – self-development – knowledge management.

UNIT IV EMPLOYEE ENGAGEMENT 9

Compensation plan – Reward – Motivation – Application of theories of motivation – Career management – Mentoring - Development of mentor – Protégé relationships- Job Satisfaction, Employee Engagement, Organizational Citizenship Behavior: Theories, Models.

UNIT V PERFORMANCE EVALUATION AND CONTROL 9

Method of performance evaluation – Feedback – Industry practices. Promotion, Demotion, Transfer and Separation – Implication of job change. The control process – Importance – Methods – Requirement of effective control systems grievances – Causes – Implications – Redressal method.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Gary Dessler & Biju Varkkey, "Human Resource Management", Pearson Publications, New Delhi, 2012.
2. Rao VSP., "Human Resources Management Text and Cases", Excel Books, 2010.
3. Aswathappa K, "Human Resource and Personnel Management – Text and Cases", Tata McGraw Hill, 2011.

REFERENCES

1. L.M.Prasad, "Personnel Management and Industrial Relations", Sultan Chand & Sons, New Delhi, 3rd Edition, 2014.
2. Mamoria.C.B& Rao V.S.P, "Personnel Management and Industrial Relations", Himalaya Publishing House, Mumbai, 20th Edition, 2014
3. VSP.Rao, Human Resource Management Text &Cases, Excel Books, Mumbai, 3rd Edition, 2011.
4. Tripathi.P.C, Personnel Management and Industrial Relations, Sultan Chand & Sons, New Delhi, 20th Edition, 2013.

19ME33N	INDUSTRIAL PSYCHOLOGY AND ORGANISATIONAL BEHAVIOUR	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Demonstrate the importance of psychology in a working environment (K2)
CO2: Describe the applicability of concept of behaviour in the management of employees (K2)
CO3: Identify different personality attributes and evaluate motivational strategies used in a variety of organizational settings. (K2)
CO4: Discuss the appropriateness of various leadership styles and conflict management strategies used in organizations. (K2)
CO5: Explain the organizational change and culture affect working relationships within organizations. (K2)

UNIT I INTRODUCTION TO PSYCHOLOGY 9

Psychology as a Science - Area of Applications – Study of Individual - Individual Differences- Study of Behaviour - Stimulus Response Behaviour - Heredity and Environment - Human Mind Cognition - Character - Thinking – Attention – Memory – Emotion.

UNIT II PERSONALITY AND VALUES 9

Definition of personality, determinants of personality, major personality attributes influence organizational behaviour – Perception – Leaning – Attitude – Value – Motivation - Theories of motivation.

UNIT III GROUP & GROUP DYNAMICS 9

Concept, importance, classification of groups, reason for group formation, group cohesiveness - Team work - Creating an effective team – Communication - Organizational conflict - Resolution of conflict – Leadership.

UNIT IV INTRODUCTION TO ORGANISATIONAL BEHAVIOUR 9

Definition – Development - Fundamental Concept - Nature of People Nature of Organization – Organizational Behaviour System – Models - Autocratic Model - Hybrid Model - Concept of Organizational Culture.

UNIT V ORGANIZATIONAL CHANGE AND DEVELOPMENT 9

Organizational effectiveness - criteria of effectiveness - Organizational Change - Process of planned Change - Organizational development Concept - Need of organizational development - difference between organizations development & management development.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Stephen P.Robbin & Seema Sanghi, "Organizational Behaviour", Pearson publications, 18th Edition, 2018.
2. L.M. Prasad, "Organizational Behaviour", S. Chand & son, 5th Edition, 2014.
3. Cecily D.Cooper & Don Hellriegel, "Mastering Organizational Behaviour", Flat world publisher, 14th Edition, 2017.

REFERENCES

1. Fred Luthans, "Organizational Behaviour: An Evidence - Based Approach**"** Mc Graw Hill International Edition, 12th Edition, 2017.
2. Ricky W. Griffin and Gregory Moorhead, "Organizational Behaviour – Managing people and organization", Cengage India Private Limited, 11th Edition, 2017.

19ME34N	**PRINCIPLES OF MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: discuss the development of management thoughts and different types of Business Organization. (K2)

CO2: Demonstrate the process of planning and decision making in an industrial situation. (K2)

CO3: Illustrate the suitable selection process for a particular job description. (K2)

CO4: Relate the importance of different motivational techniques and leadership skills in the organization. (K2)

CO5: Summarise the various controlling techniques and tools in the organization. (K2)

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

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 PLANNING 9

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 ORGANISING 9

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 DIRECTING 9

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 CONTROLLING 9

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.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Harold Koontz & Heinz Weihrich, “Essentials of Management – An International Perspective”, Tata Mcgraw Hill, 10th Edition, 2016.
2. Andrew J. Dubrin, “Essentials of Management”, Thomson South western, 9th Edition, 2011.
3. Principles of Management – P.C Tripathi, P.N Reddy, McGraw Hill Education, 6th Edition, 2017.

REFERENCES

1. Stephen P. Robbins and Mary Coulter, “Management”, Prentice Hall of India”, 8th Edition, 2012.
2. Charles W.L Hill, Steven L McShane, “Principles of Management”, Mcgraw Hill Education, Special Indian Edition, 2017.

19ME35N	BUSINESS STATISTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the key concepts and terminologies used in business statistical analysis (K2)

CO2: Summarise the concept of statistical distributions and its applications in business context (K2)

CO3: Interpret the use of hypothesis in decision making (K2)

CO4: Demonstrate the use and application of non-parametric test in decision making (K2)

CO5: Explain the uses and application of correlation in business context (K2)

UNIT I INTRODUCTION 9

Basic definitions and rules for probability, conditional probability independence of events, Baye‘s theorem, and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION 9

Introduction to sampling distributions, sampling distribution of mean and proportion, application of central limit theorem, sampling techniques. Estimation: Point and Interval estimates for population parameters of large sample and small samples, determining the sample size.

UNIT III TESTING OF HYPOTHESIS - PARAMETIRC TESTS 9

Hypothesis testing: one sample and two sample tests for means and proportions of large samples (z-test), one sample and two sample tests for means of small samples (t-test), F-test for two sample standard deviations. ANOVA one and two way.

UNIT IV NON-PARAMETRIC TESTS 9

Chi-square test for single sample standard deviation. Chi-square tests for independence of attributes and goodness of fit. Sign test for paired data. Rank sum test. Kolmogorov-Smirnov – test for goodness of fit, comparing two populations. Mann – Whitney U test and Kruskal Wallis test. One sample run test.

UNIT V CORRELATION AND REGRESSION 9

Correlation – Coefficient of Determination – Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, “Statistics for Management”, Pearson Education, 8th Edition, 2017.
2. Prem. S. Mann, “Introductory Statistics”, Wiley Publications, 9th Edition, 2015.
3. T N Srivastava and Shailaja Rego, “Statistics for Management”, Tata McGraw Hill, 3rd Edition 2017.

REFERENCES

1. Ken Black, "Applied Business Statistics", Wiley India Edition, 7th Edition, 2012.
2. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James J.Cochran, "Statistics for Business and Economics", Thomson (South – Western) Asia, Singapore, 13th Edition, 2016.
3. N. D. Vohra, "Business Statistics", Tata McGraw Hill, 2017.

19ME36N	FINANCIAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Identify the concepts of financial decision of an organisation (K2)
CO2: Explain the role of financial manager in investment decision making (K2)
CO3: Describe the concept of various budgets and its applications in financial planning (K2)
CO4: Interpret the estimation of working capital and its management (K2)
CO5: Summarise the application of break-even analysis in decision making process (K2)

UNIT I FOUNDATIONS OF FINANCE 9

Introduction to finance- Financial Management – Nature, scope and functions of Finance, organization of financial functions, objectives of Financial management, Major financial decisions – Time value of money – features and valuation of shares and bonds – Concept of risk and return – single asset and of a portfolio.

UNIT II INVESTMENT DECISIONS 9

Capital Budgeting: Principles and techniques - Nature of capital budgeting- Identifying relevant cash flows - Evaluation Techniques: Payback, Accounting rate of return, Net Present Value, Internal Rate of Return, Profitability Index - Comparison of DCF techniques - Concept and measurement of cost of capital - Specific cost and overall cost of capital.

UNIT III FINANCING AND DIVIDEND DECISION 9

Leverages - Operating and Financial leverage – measurement of leverages – degree of Operating & Financial leverage – Combined leverage, EBIT – EPS Analysis- Indifference point. Capital structure – Theories – Net Income Approach, Net Operating Income Approach, MM Approach – Determinants of Capital structure. Dividend decision- Issues in dividend decisions, Importance, Relevance & Irrelevance theories- Walter"s – Model, Gordon"s model and MM model. – Factors determining dividend policy – Types of dividend policies – forms of dividend.

UNIT IV WORKING CAPITAL MANAGEMENT 9

Principles of working capital: Concepts, Needs, Determinants, issues and estimation of working capital - Receivables Management - Inventory management – Cash

management - Working capital finance: Commercial paper, Company deposit, Trade credit, Bank finance.

UNIT V LONG TERM SOURCES OF FINANCE 9

Indian capital market- New issues market- Secondary market - Long term finance: Shares, debentures and term loans, lease, hire purchase, venture capital financing, Private Equity.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. I M. Pandey, "Financial Management", Vikas Publishing House Pvt. Ltd., 11th Edition, 2018
2. M.Y. Khan and P.K.Jain, "Financial management", Text, Problems and cases Tata McGraw Hill, 8th Edition, 2017.
3. AswathDamodaran, "Corporate Finance Theory and practice", John Wiley & Sons, 2011.

REFERENCES

1. James C. Vanhorne, "Fundamentals of Financial Management", PHI Learning, 13th Edition, 2014.
2. Brigham, Ehrhardt, "Financial Management Theory and Practice", 14th Edition, Cengage Learning 2015.
3. Prasanna Chandra, "Financial Management", 9th Edition, Tata McGraw Hill, 2017.
4. Srivatsava, Mishra, "Financial Management", Oxford University Press, 2012.

19ME37N	ACCOUNTING FOR ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the basic concept and preparation of financial accounting (K2)
CO2: Illustrate the process of preparing financial statements (K2)
CO3: Summarise the application of cost accounting for cost reduction (K2)
CO4: Discuss the technique of budgetary control in financial planning and controlling (K2)
CO5: Explain the uses of financial management for investment decision making (K2)

UNIT I INTRODUCTION 9

Introduction to Financial, Cost and Management Accounting - Objectives of Financial Accounting – Accounting Principles, Concepts and Conventions – Book keeping and Accounting – Accounting System – Preparation of Journal, Ledger, Cash Book and Trial Balance – Errors disclosed and not disclosed by Trial Balance.

UNIT II FINANCIAL ACCOUNTING 9

Salient features of Balance Sheet and Profit and Loss statement, cash flow and Fund flow Analysis (Elementary), working capital management, ratio analysis – Depreciation.

UNIT III COST ACCOUNTING 9

Cost accounting systems: Job Costing, process costing, allocation of overheads, Activity based costing, variance analysis – marginal costing – Break even analysis.

UNIT IV BUDGETING 9

Requirements for a sound budget, fixed budget – preparation of sales and production budget, flexible budgets, zero based budgets and budgetary control.

UNIT V FINANCIAL MANAGEMENT 9

Investment decisions – Investment appraisal techniques – payback period method, accounting rate of return, net present value method, internal rate of return and profitability index method-cost of capital.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Easton, Halsey, McAnally, "Financial & Managerial Accounting for MBAs", Cambridge Business Publisher, 6th Edition, 2021**.**
2. Palanivelu VR, "Accounting for Management", Lexmi Publication (P) Ltd., 2017.
3. Paul M. Collier, "Accounting for Managers: Interpreting Accounting Information for Decision–Making" John Wiley & Sons, 4th Edition, 2012.

REFERENCES

1. Jan Williams, "Financial and Managerial Accounting – The basics for business decisions", 17th Edition, Tata McGraw Hill Publishers, 2015.
2. Stice & Stice, "Financial Accounting Reporting and Analysis", 8th Edition, Cengage Learning, 2015.
3. M.Y.Khan & P.K.Jain, "Management Accounting", Tata McGraw Hill, 2011.

19ME38N SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the role of security market and its legal formalities for secured investment decision (K2)

CO2: Explain the use and application of fundamental analysis in investment decision (K2)

CO3: Describe the use and application of technical analysis in investment decision (K2)

CO4: Explain how to construct an efficient portfolio (K2)

CO5: Identify the various methods of portfolio evaluation (K2)

UNIT I INVESTMENT SETTING 9

Investment setting – Securities – Sources of investment information – Security market indications – Security Contract regulation Act - Investor Protection.

UNIT II FUNDAMENTAL ANALYSIS 9

Economic Analysis – Economic forecasting and stock Investment Decisions – Forecasting techniques - Economy and Industry Analysis - Industry life cycle – Company Analysis Measuring Earnings – Forecasting Earnings – Applied Valuation Techniques – Graham and Dodds investor ratios.

UNIT III TECHNICAL ANALYSIS 9

Fundamental Analysis Vs Technical Analysis – Charting methods – Market Indicators - Trend – Trend reversals – Patterns - Moving Average – Exponential moving Average – Oscillators – ROC Momentum – MACD – RSI – Stoastics.

UNIT IV PORTFOLIO CONSTRUCTION AND SELECTION 9

Portfolio analysis - Reduction of portfolio risk through diversification – Portfolio risk - Portfolio Selection - Feasible set of portfolios - Efficient set - Markowitz model - Single index model - Construction of optimum portfolio - Multi-index model.

UNIT V PORTFOLIO EVALUATION 9

Capital Asset Pricing model - Lending and borrowing - CML - SML - Pricing with CAPM - Arbitrage pricing theory– Portfolio Evaluation - Sharpe's index Treynor's index, Jensen's index – Mutual Funds – Portfolio Revision.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Kevin.S, “Security Analysis & Portfolio Management”, Prentice Hall of India Private Ltd., New Delhi, 2nd Edition, 2015.
2. V.A.Avadhani, “Securities Analysis and Portfolio Management”, Himalaya Publishing House, 2010.
3. V.K.Bhalla, “Fundamental of Investment Management”, S.Chand & Company Ltd., Kindle Edition, 2010.

REFERENCES

1. Punithavathy Pandian, “Security Analysis & Portfolio Management” Vikas Publishing House Pvt. Ltd., 2nd Edition, 2012.
2. William F Sharpe, Gordon J. Alexander and Jeffery V Bailey, “Investments”, Prentice Hall, 2012.
3. Prasanna Chandra, “Investment Analysis and Portfolio Management”, TATA McGraw Hill Publishing, 2011.
4. Ranganatham, “Investment Analysis and Portfolio Management”, Pearson Education India, 2nd Edition, 2012.

Group – V (Core/Elective courses of other discipline)

19ID01E	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: analyze the customer needs and convert them into product design specifications (K4)

CO2: perform concept generation and selection tools to identify the final concept (K4)

CO3: construct the detail design from the conceptual idea (K4)

CO4: understand rapid prototyping techniques in product development (K2)

CO5: recognize the Intellectual Property Protection methods and project management techniques (K2)

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Introduction - A Generic Development Process - Field and Market analysis - Data collection techniques - Analysis of Data, PESTEL analysis - Identifying Customer Needs - House of Quality for Specifications - Establishing Target Specifications - Setting the Final Specifications.

UNIT II CONCEPT GENERATION AND SELECTION 9

Concept generation activities - Pugh concept selection method: Concept screening; Concept scoring - Concept testing - Concepts for smart systems - Value Analysis.

UNIT III EMBODIMENT DESIGN 9

System level Design and issues - Architecture of Product - Sizing of Parts - PESTEL analysis; SWOT analysis - Theory of inventive problem solving (TRIZ) - FAST Method - Failure Mode and Effects Analysis (FMEA) - Design for Assembly - Design for Ergonomics - Virtual Manikins

UNIT IV RAPID PROTOTYPING 9

Prototyping techniques - Additive Manufacturing - Metal Additive Manufacturing techniques - Virtual Prototyping - Topology Optimization - Generative Design.

UNIT V PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY 9

Product Development Economics: Economic Analysis Process - Managing Projects: Protecting intellectual property - Patents, Trade mark and copy right.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. George E Dieter, Linda C Schmidt, “Engineering Design”, McGraw-Hill, International Edition, 5th Edition, 2012.
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, “Product Design and Development”, Tata McGraw-Hill Education, 4th Edition, 2009.

REFERENCES

1. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint, Pearson Education, 2007.
2. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 4th Edition, John Wiley & Sons, 2013.
3. Yousef Haik, Shahin T M M, "Engineering Design Process", Cengage Learning, 2nd Edition Reprint, 2010.
4. James R Evens, William M Lindsay "The Management and control of Quality" Pub: son south-western (www.swlearning.com), 6th edition.
5. Reddy G B, "Intellectual Property Rights and the Law", Gogia Law Agency, 7th Edition Reprint, 2009.
6. Subbaram N R, "Demystifying Intellectual Property Rights", Lexisexis Butterworths Wadhwa, 1st Edition, 2009.

19ID02E	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Classify the various types of disaster. (K2)
CO2: Interpret various natural and manmade disasters. (K2)
CO3: Choose a Hazard Assessment procedure. (K3)
CO4: Construct the protection measures against Disaster. (K3)
CO5: Apply Science and Technology in Disaster Management. (K3)

UNIT I INTRODUCTION TO DISASTER 9

Hazard, risk, vulnerability, disaster significance, nature, importance, dimensions and scope of disaster management - national disaster management frame work- financial arrangements- disaster- management cycle.

UNIT II SOURCES OF DISASTER 9

Natural disasters- significance, nature, types and effects - floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves, climatic change - global warming - sea level rise - ozone depletion. Manmade disasters- nuclear, chemical, biological, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents and sea accidents.

UNIT III DISASTER MITIGATION AND HAZARDS ASSESSMENT 10

Factors affecting damage – types, social status, habitation pattern, physiology and climate - Factors affecting mitigation measures - prediction – preparation - communication – area and accessibility - population - physiology and climate - Vulnerability Assessment and seismic strengthening of buildings - Vulnerability Assessment of Buildings procedure - Hazard Assessment-Visual Inspection and Study of Available Documents.

UNIT IV DISASTER MANAGEMENT 9

Disaster management - efforts to mitigate natural disasters at national and global levels - international strategy for disaster reduction- Rescue, relief And Rehabilitation, Role of National and International Agencies in Disaster Management - National Disaster Policy of India (Salient Features).

UNIT V APPLICATIONS OF SCIENCE AND TECHNOLOGY AND CASE STUDIES 8

Applications of Science and Technology (RS, GIS, GPS) - Early Warning and Prediction Systems- Earthquake, cyclone, landslides, fire accidents, accidents- case studies.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. S.K.Singh, S.C.Kundu, Shobha Singh A, - Disaster Management‖, William Publications, New Delhi, 1997.
2. Vinod K Sharma, — Disaster Management‖, IIPA, New Delhi, 1995.

REFERENCES

1. Annual Report, 2009-10, Ministry of Home Affairs, GOI.
2. K.Palanivel, — Disaster Management, Allied Publishers, 2015.

19ID03E	ENERGY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: explain the operation of Solar Thermal application and Solar Photovoltaic. (K2)
CO2: explain the operation of wind energy systems. (K2)
CO3: describe the concepts of various Bio-Energy Conversion techniques. (K2)
CO4: illustrate the concepts of other conventional and nonconventional power plants. (K2)
CO5: explain the concepts of hydrogen and fuel cell technology. (K2)

UNIT I INTRODUCTION TO SOLAR ENERGY 9

Sun - Earth Geometry, solar radiation, Solar Collectors - Application of solar thermal systems. Direct Electricity Conversion - Types of Solar cell - Solar Photovoltaic system and types.

UNIT II WIND ENERGY 9

Wind energy potential, Principle of wind energy conversion; Basic components, types and their constructional features; design considerations: wind data and site selection.

UNIT III BIO-ENERGY 9

Biomass: sources, characterization, principles of energy transfer technologies. Biogas: Feedstock, types of Biogas plant - parameters affecting biogas production.

UNIT IV OTHER POWER PLANTS 9

Layout of Hydel - thermal - Nuclear - Gas turbine - Diesel - MHD - Geo thermal - OTEC - Tidal Power Plants.

UNIT V HYDROGEN AND FUEL CELLS 9

Energy carrier: Types - Hydrogen: generation, storage, transport and utilization - thermal energy storage: Principle and utilization - Fuel cells: Technologies, types and applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Soteris Kalogirou, "Solar Energy Engineering: Processes and Systems", Academic Press, 2014.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K, 3rd Edition, 2012.

REFERENCES

1. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 2nd Edition, 2006.
2. Hart A B and Womack, G J, "Fuel Cells: Theory & Applications", Prentice Hall, 1997.
3. EI-Wakil M M, "Power Plant Technology", Tata McGraw-Hill, 2010.
4. Khandelwal K C and Mahdi S S, "Biogas Technology" - A Practical Handbook, Tata McGraw Hill, 1986.
5. Duffie J A and Beckman W A, "Solar Engineering of Thermal Processes", Wiley, 4th Edition, 2013.
6. Chetan Singh Solanki, "Solar Photovoltaics Fundamentals, Technologies and Applications", Prentice Hall of India, 3rd Edition, 2015.

19ID04E	CONTROL OF ROBOTIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply linear and nonlinear logics for developing the control system (K3)
CO2: design the linear control schemes for robotic manipulators(K3)
CO3: develop the nonlinear control strategy for agile robotic manipulators (K3)
CO4: construct the joint space and task space control schemes (K3)

UNIT I BASIC OF CONTINUOUS TIME LINEAR AND NONLINEAR CONTROL SYSTEM 12

Mathematical modeling of Mechanical system - Differential Equations – Transfer Functions, Time and Frequency domain response. Introduction to State Space Model, Solution of state equations, Canonical state models, State transition matrix, controllability, observability. Stability – Routh Hurwitz Test, Root Locus Design, Bode, Nyquist plot, Lyapunov Stability, BIBO stability, Krasovskii and Variable gradient Method.

UNIT II LINEAR CONTROL OF ROBOTICS 11

Introduction to Compensators Design Lead, Lag and Lead-Lag systems, Design of P,PI and PID controllers – State Feedback control, Pole Placement by State Feedback, Full Order and Reduced Order Observers, control law partitioning, Time varying optimal control – LQR steady state optimal control– Solution of Ricatti's equation – Application examples.

UNIT III NONLINEAR CONTROL OF ROBOTICS 11

Properties of Nonlinear Systems, Classification of Nonlinear Systems, Introduction to Phase plane method, Singular points, Limit cycles, Jump resonance, Construction of Phase Trajectory, Stability analysis by describing functions, Manipulator control design based observer based, adaptive and sliding mode control.

UNIT IV JOINT SPACE AND TASK SPACE CONTROL SCHEMES 11

Point to Point Control, trajectory generation, Continuous Path Control, Joint based control, Cartesian Control, Joint Space and Task Space Control Schemes, Introduction to state estimation, Kalman - Bucy filters.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Ogata, K., Modern control engineering, Pearson Education, 5th Edition, 2010
2. Slotine, J.-J. E., & Li, W. Applied nonlinear control. Englewood Cliffs, N.J: Prentice Hall, 1991
3. H Asada; J -J E Slotine, Robot analysis and control, J.Wiley and sons, New York, 1986

REFERENCES

1. I.J.Nagarath, M. Gopal, "Control Systems Engineering", New Age International Publications, 4th Edition, New Delhi, 2006.
2. M.Gopal, "Digital Control and state variable methods – conventional and intelligent control systems", Tata Mcgraw Hill 3rd Edition, New Delhi, 2008.

19ID05E	**PRODUCT LIFECYCLE MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Justify the importance and needs of PLM (K2)
CO2: Discuss the functions and features of PLM/PDM (K2)
CO3: Summarize the different modules offered in commercial PLM/PDM tools. (K2)
CO4: Implement PLM approaches for industrial applications. (K2)
CO5: Discuss the Integration of PLM with legacy databases, CAD and ERP systems (K2)

UNIT I INTRODUCTION 9

Product life cycle – Stages: Introduction, growth, maturity & decline – Marketing strategies - Product Lifecycle Management (PLM), Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources – Application Lifecycle Management (ALM).

UNIT II FUNCTIONS AND FEATURES OF PLM/PDM 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III MODULES IN A PDM/PLM SOFTWARE 9

Case studies based on the top few commercial PLM/PDM tools – Teamcenter, Windchill, ENOVIA, Aras PLM, SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.

UNIT IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, computer, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten-step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

UNIT V CUSTOMIZATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy database, CAD, SLM and ERP.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Antti Saaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008.
2. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

REFERENCES

1. ArieKarniel and Yoram Reich, Managing the Dynamics of New Product Development Processes: A New Product Lifecycle Management Paradigm, Springer, 2011.
2. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realization”, Springer Publisher, 2011.
5. Kevin Roebuck, Product Lifecycle Management (PLM): High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Emereo, 2011.

B.E. – MECHANICAL ENGINEERING

PROGRAMME ELECTIVE COURSES

19ME01E	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the concept and performance of Refrigeration and Air conditioning systems. (K2)

CO2: Demonstrate the cryogenics techniques and environmental issues of different refrigerants. (K2)

CO3: Design and select Refrigeration and Air conditioning components for different applications. (K3)

CO4: Design the Air conditioning systems using cooling load calculation, duct design and air distribution. (K3)

CO5: Demonstrate and interpret the applications of Refrigeration and Air conditioning systems. (K3)

UNIT I REFRIGERATION SYSTEMS 9

Introduction, Refrigeration machine and Reversed Carnot cycle - simple vapour compression refrigeration system - Gas cycle refrigeration - Absorption refrigeration - steam jet refrigeration, thermo electric refrigeration.

UNIT II REFRIGERANTS AND CRYOGENICS 9

Refrigerant – Properties – Classification: Halo-carbon, Azeotrope, Inorganic and Hydro Carbon refrigerants. Substitute for CFC refrigerants – Secondary refrigerants. Multistage compression and evaporator system - compound systems - cascade system, Manufacture of solid carbon di-oxide, Liquefaction of gases, Linde and Claude systems for liquefaction of air, Liquefaction of Hydrogen and Helium, Production of low temperature by adiabatic demagnetization of paramagnetic salt.

UNIT III REFRIGERATION AND AIRCONDITIONING SYSTEM COMPONENTS 9

Compressor-reciprocating, rotary, screw and scroll -Performance, capacity control and selection of compressor. Condenser - Types - Condenser capacity and efficiency, Evaporator - types, capacity and efficiency, Throttling devices-capillary tube, TEV, EEV, Solenoid valve, capacity and selection. Cooling towers.

UNIT IV AIRCONDITIONING SYSTEMS 9

Basic Air conditioning processes, cooling load calculations, Air duct design, Design of room air distribution, Air handling unit, Types of Air conditioner, VAV and VRV Systems.

UNIT V APPLICATIONS OF REFRIGERATION AND AIRCONDITIONING SYSTEMS 9

Cold storages and low temperature applications, quick freezing, Ice manufacturing, milk processing, Food Preservation, Marine Air-conditioning, Transport refrigeration, Humidification plant for textile mills/textile processing, solar cooling.

L:45; TOTAL:45 PERIODS

Note: ***Use of Refrigeration tables and charts are permitted in the End Semester Examination***

TEXT BOOKS

3. Arora C P, "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi, 2010.
4. Ananthanarayanan P N, "Basic Refrigeration and Air conditioning", Tata McGraw-Hill Education, 4th Edition 2013.

REFERENCES

6. Manohar Prasad, "Refrigeration and Air conditioning", New Age International (P) Ltd., Revised 2nd Edition Rev. 2011.
7. http://nptel.ac.in/courses/Webcourse-Contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html
8. ISHRAE-HVAC Engineers Handbook, Second Edition, 2014.
9. ASHRAE Handbook for HVAC.
10. IS 1391 (PART 2): 1992 Room Air Conditioners -Specification/

19ME02E	DESIGN OF HEAT EXCHANGER AND PRESSURE VESSEL	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the types and working of heat exchangers and regenerators. (K2)
CO2: Demonstrate the design of heat exchanger. (K2)
CO3: Design compact heat exchangers and condensers. (K3)
CO4: Analyze the stresses in pressure vessels. (K4)
CO5: Design simple pressure vessels. (K3)

UNIT I INTRODUCTION TO HEAT EXCHANGERS 12

Heat exchangers - shell and tube heat exchangers - regenerators and recuperators - Parts description, classification as per Tubular Exchanger Manufacturers Association.

UNIT II DESIGN OF HEAT EXCHANGERS 12

Thermal design using ε-NTU, P-NTU and LMTD methods - Effectiveness - Optimization - Calculation of heat Transfer Coefficient - Calculation of Pressure Drops - Mechanical design of baffles and tube sheets - Complete Problems - Exposure to HTRI Software.

UNIT III COMPACT HEAT EXCHANGERS, CONDENSERS AND COOLING TOWERS 12

Types- Merits and Demerits - Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations - Design of surface and evaporative condensers - cooling tower - performance characteristics.

UNIT IV STRESSES IN PRESSURE VESSEL 12

Introduction - Stresses in a circular ring, cylinder Membrane stress Analysis of Vessel - Cylindrical, spherical and, conical heads - Introduction to ASME Section VIII and Section II standards, internal pressure, external pressure calculation of cylindrical, spherical and conical heads using ASME Section VIII, nozzle thickness and reinforcement calculations, WRC. Thermal Stresses - Discontinuity stresses in pressure vessels. Exposure to Pressure Vessel Elite (PV Elite) Software.

UNIT V DESIGN OF PRESSURE VESSEL 12

Design of horizontal pressure vessel using ASME Section VIII- Supports, Saddles and lifting lugs for vessels - Theory of Reinforcement - Pressure Vessel Design for horizontal and vertical vessels, introduction to design of storage tanks, exposure to API 650 Standard and IS 803 Design of tanks.

L:30; P:30; TOTAL:60 PERIODS

Note: ***Use of approved design data book is permitted in the End Semester Examination***

TEXT BOOKS

1. SadikKakac and Hongtan Liu, "Heat Exchangers Selection", Rating and Thermal Design, CRC Press, 2012.
2. Shah RK, Dušan P Sekulić, "Fundamentals of heat exchanger design", John Wiley & Sons, 2003.

REFERENCES

1. KuppanThulukkanam, “Heat Exchanger Design Handbook “, Second Edition, CRC Press, 2013.
2. Heat Exchanger Equipment Field Manual. Gulf Professional Publishing, 2012.
3. Manfred Nitsche, Raji OlayiwolaGbadamosi, Heat Exchanger Design Guide: A Practical Guide for Planning, Selecting and Designing of Shell and Tube Exchanger, Butterworth-Heinemann, 2015.
4. Handbook for Heat Exchangers and Tube Banks Design, D. Annaratone, Springer Verlag, 2010
5. ASME SEC VIII DIV-1 Boiler and Pressure Vessel Code: Rules for Constructing Pressure Vessels, ASME, 2013.
6. Dennis Moss, “Pressure Vessel Design Manual” Gulf professional Publishing, Third Edition 2012.
7. ASME Boiler and pressure vessel code Section VIII
8. ASME Boiler and pressure vessel code Section II
9. API 650 Tank design codes
10. IS 803 Code of practice for design, of storage tanks.

19ME03E	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Identify the automobile structure, various systems and components, comfort and safety systems. (K2)

CO2: Differentiate between the principles of SI and CI engines and discuss the recent development in the area of alternates for automotive engines. (K2)

CO3: Explain the need and components of the transmission system in an automobile. (K2)

CO4: Describe the constructional features and components of the steering, brake and suspension system. (K2)

CO5: Appraise recent trends in Electrical and Electronics for Engine and Vehicle Management System. (K2)

UNIT I VEHICLE STRUCTURE, COMFORT AND SAFETY 9

Automobiles - Vehicle Construction - layouts, chassis, frame, body material, design and construction. Vehicle Aerodynamics. Ergonomics and anthropometry - Driver seat for comfort and safety, safety belts, Air bags, Crumple Zone, driver drowsiness detection system. Recent trends in automotive safety systems - Safety regulations and testing.

UNIT II ENGINE AND AUXILIARY SYSTEMS 9

Fuel Injection System - MPFI, GDI & CRDI, Turbochargers. Variable Timing Control (VTC), Variable Valve Timing (VVT), Variable compression ratio (VCR) and Lift Electronic Control (VTEC), Homogenous Charge Compression Ignition (HCCI) Advanced Turbulent Flow Technology (ATFT), Emission control and standards - EGR and Catalytic Converter.

UNIT III TRANSMISSION SYSTEMS 9

Transmission system - need and Construction of Clutch, Gear Box - Manual and Automatic - Over Drives - Transfer Box, Fluid flywheel, Torque convertors. Continuously Variable Transmission (CVT). Propeller shaft - Hotchkiss drives, Torque tube drive, Universal joints. Differential. Rear axle types and construction.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Front axle - types, construction and materials. Steering Geometry - steering gear box, power steering. Braking Systems - Types - braking torque. Exhaust brakes, power and power assisted brakes. Antilock Braking System (ABS), Electronic Brake Force Distribution (EBD) and Traction control.

Suspension - types, factors influencing ride comfort, shock absorbers. Static and rolling properties of pneumatic tyres - tubeless tyres, aspect ratio, tyre wear and maintenance.

UNIT V AUTOMOTIVE ELECTRICAL AND ELECTRONICS 9

Introduction to automotive electrical systems - Automotive electricity generation, storage & distribution systems, wiring harness. Charging, starting & ignition System - Bendix drive, over running clutch drive. Automotive lighting. Automotive Sensors & Actuators, Engine

Management Control, Body Control Module. Vehicle Management System - vehicle tracking system, Collision avoidance, Radar warning system, Global Positioning Systems.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Kirpal Singh, Automotive Engineering, Vol. I & II, 14th Edition, Standard Publishers, New Delhi, 2017.

REFERENCES

1. Newton, K., Steeds, W., and Garrett, T.K., "The Motor Vehicle", 13th Edition Butterworth, 2000.
2. David C Barton, John D Fieldhouse, "Automotive Chassis Engineering", Springer, 2018.
3. Joseph Heitner, "Automotive Mechanics", 2nd Edition, East-West Press, 2004.
4. Heinz Heisler, "Advanced Engine Technology", SAE international publications USA, 1995.
5. William B.Riddens "Understanding Automotive Electronics", 5th Edition, Butter worth Heinemann Woburn, 2013.
6. Automotive Safety Handbook by Ulrich W. Seiffert and Lothar Wech, SAE International, 2007.

19ME04E	INTERNAL COMBUSTION ENGINES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Discuss the combustion phenomenon and influence of combustion chamber design parameters in IC engines (K2)

CO2: Discuss fuel metering and fuel supply systems of I C engines. (K2)

CO3: Describe the effect of engine emission on environment, their measurement and control techniques incorporating the standard emission norms. (K2)

CO4: Identify the viable alternate fuels for IC engines for the emission control and sustainable development. (K2)

CO5: Describe recent trends in IC engines and the principle of modern engine management systems. (K2)

UNIT I COMBUSTION PHENOMENA IN SI AND CI ENGINES 9

Normal and Abnormal combustion of SI and CI engines - Factors influencing abnormal combustion - Types of Combustion chambers of SI and CI engines - Effect of combustion chamber design and engine parameters on the combustion of both engines.

UNIT II FUEL SUPPLY SYSTEMS OF SI AND CI ENGINES 9

Fuel Supply systems in SI engines - Air-fuel ratio requirements, Design of carburettor - Electronic Fuel Injection Systems and their types - Fuel Supply systems in CI engines - Components - Description - Supercharging and Turbo charging.

UNIT III ENGINE EMISSION AND CONTROL 9

Emissions from SI and CI engines - Mechanism of formation of NOx, HC, CO, Smoke and Particulate emissions, Emission measuring equipment's, Methods of controlling emissions, Indian Driving Cycles and emission norms-Indian/International.

UNIT IV ALTERNATE FUELS 9

Need for Alternate fuels - Oxygenated Fuels, Vegetable oils and bio-diesel, gaseous fuels, Hydrogen - Properties and Suitability of the alternate fuels, Engine - Modifications, Performance, Combustion and Emission Characteristics of SI and CI Engines using these alternate fuels.

UNIT V RECENT TRENDS IN IC ENGINES AND ENGINE MANAGEMENT SYSTEMS 9

Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Variable Compression Ratio Engine, Dual Fuel Engine, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Engine Electronics Management, Data Acquisition System - pressure pick up, charge amplifier PC for Combustion and different sensors used in engine management system - Introduction to simulation of IC engine - Hybrid electric vehicle.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. John B Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill Education (India) Pvt. Limited, 2017.
2. Ganesan V, "Internal Combustion Engines", Tata McGraw-Hill, 4th Edition, 2017.

REFERENCES

1. Richard Stone, "Introduction to Internal Combustion Engines", Palgrave Macmillan, 3rd Edition, 2012.
2. Gupta H N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India, 2nd Edition, 2014.
3. Allan T. Kirkpatrick Colin R. Ferguson, "Internal Combustion Engines: Applied Thermal Sciences" 2nd Edition, Wiley India 2011.
4. Mathur.M L and Sharma.RP, "Internal Combustion Engines", Dhanpat Rai and Sons, 2008.
5. SAE International Journal of Engines.
6. http://nptel.ac.in (Engine Combustion, Engine Emissions).

19ME05E	GAS DYNAMICS AND PROPULSION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Calculate the adiabatic and isentropic properties in various regions of flow. (K2)

CO2: Evaluate the adiabatic and isentropic properties in various conditions of flows during friction, heat transfer and mass addition. (K2)

CO3: Derive the conditions for the change in pressure, density and temperature for flow through a normal, oblique and expansion shock waves. (K2)

CO4: Explain how thrust and shaft powers are interrelated in various types of propulsion engines. (K2)

CO5: Apply the gas dynamics principles in the space propulsion. (K2)

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows - Stagnation states, Mach waves and Mach cone - Effect of Mach number on compressibility - Isentropic flow through variable ducts - Nozzle and Diffusers.

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - variation of flow properties - Simple flow with mass addition.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl-Meyer relations - Wind Tunnel - Applications.

UNIT IV JET PROPULSION 9

Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines - Propellants-feeding systems - Ignition and combustion - Theory of rocket propulsion - Performance study - Staging - Terminal and characteristic velocity - Applications - space flights.

L:45; TOTAL:45 PERIODS

Note:*Use of approved Gas Table is permitted in the End Semester Examination*

TEXT BOOKS

1. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International Publishers, Sixth Edition, 2018.
2. EthirajanRathakrishnan, Gas dynamics, PHI Learning, sixth Edition 2017.

REFERENCES

1. V Ganesan, Gas Turbines, McGraw Hill Education, third Edition, 2017.
2. Hill, Mechanics and Thermodynamics of Propulsion, pearson publishers, second Edition, 2009
3. John Anderson, Modern Compressible Flow: with Historical Perspective, McGraw Hill Education, third Edition, 2017.
4. Patrick H. Oosthuizen, Introduction to Compressible Fluid Flow (Heat Transfer), CRC Press, second Edition, 2013.
5. Balachandran P, Gas Dynamics for Engineers, PHI Learning, 2010.

19ME06E	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the construction, operation of various components of thermal power plant and performance of steam boilers. (K2)

CO2: Describe the functions of different components of nuclear and hydel power plants. (K2)

CO3: Summarize the functions of different components of diesel and gas turbine power plants. (K2)

CO4: Explain the basic concept and working of Solar, Wind and Bio-Energy power plants. (K2)

CO5: Recognize the environmental and regulatory issues related to various power plants and Estimate the economy of power plants. (K3)

UNIT I THERMAL POWER PLANT 9

Layout - Fuel and ash handling, Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught, condenser and Cooling Towers - Steam Boilers - High pressure and Super Critical Boilers - Fluidized Bed Boilers - Performance of boiler - Environmental effects.

UNIT II NUCLEAR AND HYDEL POWER PLANTS 9

Nuclear Energy - Fission, Fusion Reaction, Types of Reactors, Waste disposal and safety-nuclear waste transportation norms - Hydel Power plant - Layout - Essential Elements, Selection of turbines, governing of Turbines- Micro hydel developments.

UNIT III DIESEL AND GAS TURBINE POWER PLANT 9

Layout - Types of diesel plants, components, Selection of Engine type, applications - Gas turbine Power plant - Layout - Gas turbine material - open and closed cycles - reheating - Regeneration and inter cooling - combined cycle.

UNIT IV SOLAR, WIND AND BIO ENERGY POWER PLANT 9

Radiation, Solar Collectors - Application of solar thermal systems, Direct Electricity Conversion. Wind energy potential, Principle of wind energy conversion; Basic components, types and their constructional features; Biomass: sources, characterization, principles of energy transfer technologies.

UNIT V ECONOMICS AND ENVIRONMENTAL EFFECT OF POWER PLANTS 9

Cost of Electric Energy - Fixed and operating costs - Energy rates - Types tariffs - Economics of Load sharing - comparison of various power plants - Emission from various power plants -Environmental affects and its remedies - Environmental regulatory and norms for power plant.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Arora SC and Domkundwar S, "A Course in Power Plant Engineering", Dhanpat Rai, Eighth Edition 2016.
2. EI-Wakil MM," Power Plant Technology", Tata McGraw-Hill, 2010.

REFERENCES

1. Sharma SC and Nagpal, "A Text Book of Power Plant Engineering", Jain publication, 16th Edition, 2015.
2. Nag PK, "Power Plant Engineering", Tata McGraw- Hill, 4th Edition, 2017.
3. Ramalingam KK, "Power Plant Engineering", Scitech Publications, 2015.
4. Rai GD, "Introduction to Power Plant technology", Khanna Publishers, 11th Reprint Edition, 2013.
5. Indian boiler regulations (IBR) Act, 2005.

19ME07E	**RENEWABLE ENERGY SOURCES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explicate the physics of solar radiation and estimate the solar energy potential and its availability. (K2)

CO2: Interpret the different solar energy collectors for solar energy conversion. (K2)

CO3: Familiarize with the concepts of different solar energy storage techniques and its applications. (K2)

CO4: Interpret the concepts of extraction of wind energy and various Bio-Energy conversion techniques (K2)

CO5: Recognize the other available forms of renewable energy sources. (K2)

UNIT I SOLAR RADIATION 9

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

UNIT II SOLAR ENERGY COLLECTORS 9

Flat plate and concentrating collectors - Heat removal rate- Useful energy gain - Losses in the collectors - efficiency of flat plate collectors - testing of flat plate collectors. Concentric collectors - classification of concentrating collectors - concentrator mounting - tracking mechanism - thermal analysis, advanced collectors.

UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 8

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications - solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT IV WIND ENERGY and BIO ENERGY 9

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT V OTHER RENEWABLE ENERGY SOURCES 10

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Rai G.D. “Non-Conventional Energy Sources”, Khanna Publishers, 2013.
2. Twidell& Wier, “Renewable Energy Resources”, CRC Press (Taylor & Francis), 2011.

REFERENCES

1. Tiwari and Ghosal, “Renewable energy resources”, Narosa Publishing House, Re-print 2015.
2. Ramesh R & Kumar K.U, “Renewable Energy Technologies”, Narosa Publishing House, Re-print 2018.
3. Solanki, Chetan Singh “Renewable Energy Technologies: A Practical Guide for Beginners”, 2nd Edition, P.H.I, New Delhi, 2013.
4. Kothari D.P, Singhal., K.C., “Renewable energy sources and emerging technologies”, 2nd Edition, P.H.I, New Delhi, 2015.

19ME08E SOLAR PHOTOVOLTAIC ENERGY CONVERSION

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: recognize the fundamentals of solar cells. (K2)
CO2: understand the various solar cell fabrication processes. (K2)
CO3: realize the technology of PV module assembly (K2)
CO4: design and analyze on-grid PV applications. (K3)
CO5: design off-grid PV systems and perform cost benefit analysis of PV installations. (K3)

UNIT I SOLAR CELL FUNDAMENTALS 9

Fundamentals of Semiconductors, energy band, direct & indirect band gap, doping, PN Junction, charge carriers, carrier motion & recombination, Photovoltaic effect, Solar cells - Design characteristics, parameters influencing performance, losses in solar cells, Solar radiation measurement - pyranometer, pyrheliometer.

UNIT II SOLAR CELL FABRICATION 9

Preparation of metallurgical, electronic and solar grade silicon - Production of polycrystalline and monocrystalline silicon: Czochralski (CZ) and Float zone (FZ), wafer dicing, refining. Thin film solar cells - A-Si, CIS/CIGS, Thin film deposition techniques - Physical vapour deposition (PVD), Chemical vapour deposition (CVD) - Plasma enhanced CVD, Emerging technologies - Organic cells, Multi-junction cells, Dye sensitized cells.

UNIT III SOLAR PV MODULE ASSEMBLY 8

Diffusion, Optical loss minimization - Anti reflective coating, Surface texturing, minimization of recombination - Surface passivation, Metal contacts - pattern defining and deposition. PV module fabrication: Number of cells in a module, blocking and bypass diode, packing density, Hot spots, Solar simulator: I-V measurement, PV module specifications.

UNIT IV ON-GRID PV SYSTEMS 9

PV string and array - Balance of system -DC-DC converters - Inverters - Maximum power point tracking - On-Grid PV system - Design & analysis -Net Metering - Performance evaluation& monitoring - Field visit - Grid tied PV power plant.

UNIT V OFF-GRID PV SYSTEMS 10

Off-Grid standalone PV system -System sizing - Module & Battery-Charge controller - Storage Batteries for PV systems -Design & analysis - Performance evaluation & monitoring - Economic indicators: Simple payback, Life cycle costing.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Chetan Singh Solanki “Solar Photovoltaics Fundamentals, Technologies and Applications”, 3rd Edition, Prentice Hall of India, 2015.

REFERENCES

1. Chetan Singh Solanki “Solar Photovoltaic Technologies and Systems - A manual for Technicians, Trainers and Engineers”, Prentice Hall of India, 2014.
2. Robert Foster Majid Ghassemi, Alma Cota “Solar Energy - Renewable Energy and the Environment”, CRC Press, 2010.
3. James P. Dunlop, “Photovoltaic Systems”, 3rd Edition, American Technical Publishers, 2015.
4. A. Goetzberger,V.U. Hoffmann “Photovoltaic Solar Energy Generation”, Springer-Verlag Berlin, Heidelberg, 2019.
5. Martin Green “Solar Cells: Operating principles, technology and systems application”, Prentice Hall, 2016.
6. www.pveducation.org

19ME09E	THERMAL DESIGN AND MANAGEMENT OF ELECTRONIC EQUIPMENTS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO1: Explain the needs of thermal management in electronics packaging. (K2)
CO2: Apply the concept of conduction in cooling for electronic circuit board. (K3)
CO3: Estimate the performance of convective cooling in electronics. (K3)
CO4: Utilize the concept of heat pipe in latest electronic equipment. (K3)
CO5: Estimate the thermal and electrical reliability of the electronic equipment. (K3)

UNIT I INTRODUCTION TO THERMAL MANAGEMENT 8

Introduction - importance of thermal management of electronics - Issues in Electronics packaging design - technical management issues - temperature effects on different failure modes - Basics of conduction, convection and radiation heat transfer in electronic components - Cooling Specifications for Electronics.

UNIT II HEAT CONDUCTION IN ELECTRONIC EQUIPMENTS 10

Mountings of electronic components - uniformly distributed heat source, steady state conduction - thermal resistance, junction to case resistance, contact interface resistance - circuit board with an aluminum heat sink core, chassis with non-uniform wall sections, heat conduction through sheet metal cover and heat transfer in cylindrical shell.

UNIT III HEAT CONVECTION IN ELECTRONIC EQUIPMENTS 10

Free convection - flow through flat horizontal and vertical plates - finned surface - cooling for PCB - forced Convection cooling - fan cooled electronic box - hollow core PCB - undesirable airflow reversal - direct air impingement cooling - finned cold plate and heat exchanger - effect of altitude in heat exchanger performance.

UNIT IV SPECIAL APPLICATION FOR COOLING 9

Introduction to latest technology in cooling - Heat Pipes - degraded performance in heat pipes - performance - application - Liquid cooling - direct and indirect cooling - forced liquid cooling systems - pumps for cooling - liquid coolant - simple liquid cooling systems - mounting components for indirect liquid cooling - transistors on water cooled cold plate - solid state thermoelectric cooling.

UNIT V RELIABILITY ANALYSIS 8

Mechanical reliability - stress analysis - engineering assumption - failure - life expectancy - thermal stress and strains. Electrical reliability - MTTF - first year failure - reliability model - system failure rate.

L:45 TOTAL: 45 PERIODS

Note:*Use of HMT data book is permitted in the end semester examinations.*

TEXT BOOKS

1. Practical Guide to the packaging of electronics - Thermal and Mechanical design and analysis, Ali, CRC press Inc, 3rd Edition, 2016.
2. Cooling Techniques for Electronics Equipment, Dave S. Steinberg, John Wiley & Sons, 2nd revised Edition, 1991.

REFERENCES

1. Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press Inc, 2010.
2. Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.
3. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill, 2019.
4. Yunus A. Cengel, Heat Transfer: A Practical Approach, McGraw-Hill, 2008.
5. Sung Jin Kim, Sang Woo Lee, Air Cooling Technology for Electronic Equipment, Taylor & Francis, 2020.

19ME10E	ENERGY CONSERVATION AND WASTE HEAT RECOVERY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO1: Describe the necessity and various energy conservation methods to meet the present energy scenario. (K2)

CO2: Explain the basic characteristics of instruments for energy conservation. (K2)

CO3: Recognize the various measures for energy conservation in thermal utilities. (K2)

CO4: Familiarize with recent energy efficient opportunities in electrical utilities. (K2)

CO5: Explain the concept and significance of various waste heat recovery systems. (K2)

UNIT I INTRODUCTION 7

Energy Scenario - Principles and Imperatives of Energy Conservation - Energy Consumption Pattern - Resource Availability in India and worldwide - Energy Audit-Purpose, Methodology for various applications and Report Preparation - Role of Energy Auditor in Industries.

UNIT II INSTRUMENTS FOR ENERGY CONSERVATION PROCESS 9

Instrument characteristics - Measurement of flow, velocity, pressure, temperature, speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality.

UNIT III ENERGY CONSERVATION IN THERMAL UTILITIES 11

Various Energy Conservation Measures in Steam System - Losses in Boiler - Steam Traps- Types, Function and Necessity - Energy conservation in pumps, Fans & Compressors, Air conditioning and refrigeration systems.

UNIT IV ENERGY CONSERVATION IN ELECTRICAL UTILITIES 9

Potential Areas for Electrical Energy Conservation in Various Industries-Energy Management Opportunities in Electrical Heating, Lighting system, Cable selection - Energy Efficient Motors - Factors involved in Determination of Motor Efficiency.

UNIT V WASTE HEAT RECOVERY SYSTEMS 9

Selection criteria for waste heat recovery technologies - Recuperators, Regenerators, Economizers - Plate Heat exchangers, fluidized bed heat exchanger, heat pipes exchanger - heat pumps, sorption systems - Waste heat boilers design Considerations.

L: 45; TOTAL: 45 PERIODS

TEXT BOOKS

1. Steve Doty, Wayne C. Turner, “Energy management handbook”, 8th Edition, lulu Press, Inc., 2013.
2. F Kreith, D.Y. Goswami, “Energy management and conservation handbook”, 2nd Edition, Taylor & Francis, 2016.

REFERENCES

1. Patrick, Energy Conservation Guidebook, 3rd Edition, Taylor & Francis Exclusive, 2014.
2. Taimoor Pervez, Sohaib Ejaz Randhawa, Nauman Sadiq, Waste Heat Recovery and Energy Conservation of Arl Distillation Unit, LAP publisher, 2011.
3. Steven Fawkes, Energy Efficiency: The Definitive Guide to the Cheapest, Cleanest, Fastest Source of Energy 1st Edition, Rout ledge publication, 2013.
4. Ming Yang, Xin Yu, Energy Efficiency: Benefits for Environment and Society (Green Energy and Technology), 2015.

19ME11E	HEATING VENTILATION AND AIR CONDITIONING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand the concept of HVAC system. (K2)
CO2: Evaluate heat load calculations. (K3)
CO3: Understand the basic principle and components of ventilation system. (K2)
CO4: Discuss the concept of chilled water system. (K2)
CO5: Identify and selection of HVAC components. (K3)

UNIT I INTRODUCTION TO HVAC SYSTEM 9

Scope of HVAC Industry with overview of Consulting & Construction industry, Concepts of Air conditioning Systems, Refrigeration cycle, cooling and heating system, Chilling system, Humidification and dehumidification methods, Filtration, Air conditioning system- Window, Split, Packaged and Centralized, Chilled water system, Psychrometric chart and Properties of air, Refrigerants, Refrigerant pipe sizing.

UNIT II HEAT LOAD ESTIMATION 9

Introduction to ASHRAE and ISHRAE standards, Basics of Heat Transfer in a building envelop, understanding of outdoor and indoor conditions, Factors affecting the Load estimate, Sources of external and internal heat gain, Heat gain through ventilation and infiltration air, Heat gain through duct, Calculating RSH, RLH, OASH, OALH, GTH, ESHF, ADP and dehumidified CFM. Demonstration of Heat load calculation with simple computing software.

UNIT III DESIGN OF AIR DISTRIBUTION SYSTEM 9

Components of Air distribution, Types of Ducts, Duct Fittings, Dampers, Types of Diffusers, Return Air Grill, Flexible Duct, Flexible connector, End Cap, Sound Attenuator, Duct elbow sections, vanes location and number of vanes required, Duct material calculation, Duct Design and Fan selection, Ventilation system - Types and components.

UNIT IV CHILLED WATER SYSTEM DESIGN 9

Introduction to chilled water and hot water system, classification chillers, chiller arrangements, cooling tower arrangements, Pumps required in chilled water system, chilled water system pipe designing, pipe designators, piping standards, piping fittings and components, valves used in chilled water system, Frictions loss in pipes, fitting, and valves, calculating TDH for pump.

UNIT V EQUIPMENT SELECTION, ERECTION AND DETAILING 9

AHU and FCU classification and selection, Selection of Package unit, DX chiller, Condenser, cooling tower and Expansion tank. Detailing and installation of chillers, AHU, package units, FCU, condensing units, Estimation of project, Drafting of HVAC systems.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Robert McDowall, “Fundamentals of HVAC Systems”, ASHRAE E-learning system, 2007.

REFERENCES

1. William Bobenhausen, “Simplified Design of HVAC Systems”, Wiley, 1994.
2. Walter T.Grondzik, “Air-Conditioning System Design Manual”, Butterwoth-Heinemann, 2007.
3. Mohsen SheikholeslamiKandelousi, “HVAC System”, Intech Open, 2018.
4. Robert McDowall, “Fundamentals of Air System Design”, ASHRAE E-learning system, 2009.

19ME12E	TURBOMACHINES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the basic principles of operation, classifications, types and applications of pumps, fans, blowers and compressors. (K2)

CO2: Analyze thermodynamically the performance of turbo machines. (K3)

CO3: Describe the geometry of blades, cascade parameters, performances of cascade. (K2)

CO4: Describe performance, design parameters and specifications of turbo machines used for different applications. (K2)

CO5: Describe the principles of operations, performance of different types of wind turbine and their applications. (K2)

UNIT I BASIC TURBO SYSTEMS 9

Turbo Machine: Basic concept and significant, Turbines, Compressors, Fan, blowers - classifications and types, working principles, applications.

UNIT II TURBOMACHINES AND THERMODYNAMIC PRINCIPLES 9

Turbomachine - Application of Laws of thermodynamics, thermal performance - different types of thermal efficiencies.

UNIT III DYNAMIC ANALYSIS 9

Aerofoil, blade geometry, cascades, cascade analysis, different types of losses, estimation of losses, design concepts.

UNIT IV SELECTION OF TURBO-MACHINES 9

Non-dimensional parameters - Performance of turbomachines -losses and performance curves - design condition and off design conditions - design parameters - specifications - selection criteria.

UNIT V WIND TURBINES 9

Types - Construction and working - performance - latest developments - small and micro wind mills.

L:45; TOTAL:45 PERIODS

Note: Use of Gas tables and steam tables are permitted in the End Semester Examination

TEXT BOOK

1. Yahya S M, "Turbines, Compressors & Fans", Tata-McGraw Hill Co., 2017.

REFERENCES

1. Kadambi V and Manohar Prasad, "An Introduction to energy conversion", Volume III - Turbo machinery, New Age International Publishers (P) Ltd., Second Edition, 2011.
2. Gopalakrishnan G and Prithvi Raj D, "A Treatise on Turbo machines", ScitechPublications India Pvt. Ltd., 2008.
3. William W Perg, "Fundamentals of Turbomachinery" John Wiley & Sons, Inc. 2008.
4. Logan R, Ramendra R, "Handbook of Turbomachinery", Marcel-Dekker, 2nd Edition Revised, 2003.

19ME13E	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: discuss the components mechanisms in automotive starting system (K2)
CO2: describe the constituents and working of charging and lighting systems (K2)
CO3: express the importance of electronics in ignition and fuel injection systems (K2)
CO4: explain the role of sensors and microprocessors in automobiles (K2)
CO5: explain the safety systems in recent automobiles (K2)

UNIT I BATTERIES AND STARTING SYSTEM 9

Different types of Batteries-principle, rating, testing and charging. Starter motors characteristics, capacity requirements. Drive mechanisms- Bendix drive, Overrunning clutch drive. Starter switches.

UNIT II CHARGING SYSTEM LIGHTING AND ACCESSORIES 9

DC Generators and Alternators their characteristics. Control unit- cut out, electronic regulators, bridge rectifiers. Vehicle interior lighting system. Vehicle exterior lighting system. Wiring requirements. Lighting design. Dashboard instruments. Horn - Horn relay.

UNIT III ELECTRONIC IGNITION AND INJECTION SYSTEM 9

Spark plugs - Spark advance mechanisms - Different types of ignition systems. Electronic fuel injection systems, mono and multi point fuel injection system (MPFI).

UNIT IV SENSORS AND MICROPROCESSORS 9

Basic sensor arrangements. Types of sensors - oxygen sensor, hot wire anemometer sensor, vehicle speed sensor, detonation sensor, accelerometer sensor, crank position sensor. Microprocessor and microcomputer - controlled devices in automobiles - voice warning system, travel information system, keyless entry system, automatic transmission system, electronic steering system.

UNIT V SAFETY SYSTEMS 9

Antilock braking system, air bag restraint system, voice warning system, seat belt system, road navigation system, anti-theft system.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. A. L. Statini, "Automotive Electrical and Electronics", Delmar Publications, 2013.
2. Tom denton, "Automotive Electrical and Electronics Systems", Allied Publishers, 2016.

REFERENCES

1. William B.Riddens "Understanding Automotive Electronics", 5th Edition, Butter worth Heinemann Woburn, 2013.
2. A K Babu, "Automotive Electrical and Electronics", Khanna Publishers, 2016.
3. J Marek, H P Trah, Y Suzuki, I.Yokomori, "Sensors for Automotive Applications", Wiley-VCH, 2003.

19ME14E	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the methods of energy storage (K2)
CO2: Describe sensible and latent heat thermal energy storage system (K2)
CO3: Understand the concept of mechanical and chemical energy storage (K2).
CO4: Demonstrate the storage behavior in electro chemical systems (K2)
CO5: Realize the concept of electrical energy storage systems and evaluate their performance parameters (K2)

UNIT I ENERGY STORAGE METHODS 9

Introduction: Energy storage needs - Potential energy - Pumped hydro, compressed air - Kinetic energy - mechanical flywheels - Thermal energy storage with phase change material - ice, organic and inorganic PCM - Chemical energy - hydrogen, methane - Electrochemical energy - batteries, fuel cells - Electrostatic energy - capacitors, Electromagnetic energy - superconducting magnets.

UNIT II THERMAL ENERGY STORAGE SYSTEMS 9

Thermal Energy Storage Concepts - Materials for Sensible and Latent Heat Storage - Simple water and Rock-bed storage systems; pressurized water storage system - Phase

Change Materials (PCMs); Selection criteria of PCMs; Organic, Inorganic Eutectic Materials, Materials for Low and High Temperature Storage Applications.

UNIT III MECHANICAL AND CHEMICAL ENERGY STORAGE SYSTEMS 9

Pumped hydro energy storage, Compressed air energy storage, Energy storage in Advanced Flywheels, Hydrogen Energy - production of hydrogen by reforming & electrolysis, Hydrogen storage methods.

UNIT IV ELECTROCHEMICAL ENERGY STORAGE SYSTEMS 9

Introduction to batteries, factors effecting battery performance, storage density, energy density, losses in cells - Battery classification, Lithium; Lead acid batteries; Nickel Cadmium batteries; Advanced batteries - (i) zinc-Air (ii) Nickel Hydride.

Introduction to fuel cells, hydrogen-oxygen cells, hydrogen-air cell, hydrocarbon-air cell, alkaline fuel cell - advantages and drawbacks.

UNIT V ELECTRIC ENERGY STORAGE SYSTEMS 9

Capacitor: Comparison and application; Super capacitor: Basic components, Electrochemical Double Layer Capacitor (EDLC), principle of working, structure, performance and application, role of activated carbon and carbon nano-tube. Electromagnetic energy storage: Superconducting Magnetic Energy Storage.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Robert Huggins, 'Energy Storage: Fundamentals, Materials and Applications', 2nd Edition, Springer, 2015.

REFERENCES

1. Yves Brunet., 'Energy storage', Wiley publications, 2013.
2. Detlef Stolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", Wiley, 2010.
3. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, 'Electrochemical Technologies for Energy Storage and Conversion', John Wiley and Sons, 2012.
4. Francois Beguin and Elzbieta Frackowiak, 'Super capacitors', Wiley, 2013.
5. Ibrahim Dincer and Mark A Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley and Sons 2011.
6. Luisa F.Cabeza., 'Advances in thermal energy storage systems', Woodhead publications, 2014.

19ME15E	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon successful completion of the course the students will be able to

CO1: Apply computational techniques for solving engineering problems. (K3)
CO2: Discuss the fundamentals and procedures used in CFD/FEM. (K3)
CO3: Apply CFD to analyze the fluid flow. (K4)
CO4: Apply CFD to analyze the thermal systems. (K4)
CO5: Perform static and dynamic analysis using FEA in structural members. (K4)

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 12

Basics of computational fluid dynamics - Governing equations of fluid dynamics - Continuity, Momentum and Energy equations - Physical boundary conditions - Laminar and Turbulent Flow - Turbulent-Kinetic Energy Equations - Mathematical behaviour of PDEs on CFD -Elliptic, Parabolic and Hyperbolic equations.

UNIT II TURBULENCE MODELS AND MESH GENERATION 12

Turbulence models, mixing length model, Two equation (k-Є) models - High and low Reynolds number models - Structured Grid generation - Unstructured Grid generation - Mesh refinement - Adaptive mesh - Software tools.

UNIT III APPLIED PROJECTS CFD - I 12

Internal Fluid flow - Pipe bends, Branch and lateral-Symmetric - Transient - Header Flow Distribution Post processing - Different CFD Outputs: Contour plots - Surface Plots, Plotting, Vectors, Turbulence Modeling External Flow - Flow over a circular cylinder, simple car and aero plane.

UNIT IV APPLIED PROJECTS CFD - II 12

Radiation problems - Heat Transfer distribution - Porous media - Pump - Fan - Gaseous Combustion -Particle Study - Multi phase problems.

UNIT V APPLIED PROJECTS FEA 12

Stress - Strain - FOS -Machine elements under Static Structural Loads - Modal Analysis - Thermal Analysis - Vibrations - Non-Linear Analysis.

L:30; P:30; TOTAL: 60 PERIODS

TEXT BOOKS

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition, 2007.
2. Jiyuan TL, Guan HengYeoh, “Computational Fluid Dynamics A Practical Approach” Butterworth-Heinemann, First Edition 2008.

REFERENCES

1. Hyoung Woo Oh, “Applied Computational Fluid Dynamics”, InTech Publishers, 2012.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005.
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

5. Prodip Niyogi, Chakrabarty, S.K., Laha, M.K. "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
6. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.
7. Anderson “Computational Fluid Dynamics the Basics with Application” Mcgraw Hill, 1996.

19ME16E HYBRID ELECTRIC VEHICLES L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the concepts of electric and hybrid vehicle and drive trains. (K2)
CO2: Identify and select suitable components of propulsion systems for electric vehicles (K2)
CO3: Recognize the proper energy storage systems for vehicle applications (K2)
CO4: Estimate the size of the drive system of electric vehicles (K2)
CO5: Explain the energy management strategies of electric and hybrid electric vehicles. (K2)

UNIT I INTRODUCTION TO HYBRID ELECTRIC VEHICLES 9

History, social and environmental importance of hybrid and electric vehicles - Impact of modern drivetrains on energy supplies - Hybrid Electric Drive-trains and Electric Drive-trains - Basic concept of electric traction - Introduction to various electric drive-train topologies - Power flow control in electric drive-train topologies- Fuel efficiency analysis.

UNIT II ELECTRIC PROPULSION UNIT 9

Introduction to electric components used in hybrid and electric vehicles - Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - Configuration and control of Permanent Magnet Motor drives - Configuration and control of Switch Reluctance Motor drives - Drive system efficiency.

UNIT III ENERGY STORAGE UNIT 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles - Battery based energy storage and its analysis - Fuel Cell based energy storage and its analysis - Hybridization of different energy storage devices.

UNIT IV SIZING THE DRIVE SYSTEM 9

Matching the electric machine and the internal combustion engine (ICE) - Sizing the propulsion motor - Sizing the power electronics - Selecting the energy storage technology – Communications and supporting subsystems.

UNIT V ENERGY MANAGEMENT STRATEGIES 9

Introduction to energy management strategies used in hybrid and electric vehicles - Classification of different energy management strategies - Comparison of different energy

management strategies - Implementation issues of energy management strategies - Case Studies - Design of a Hybrid Electric Vehicle (HEV) and a Battery Electric Vehicle (BEV).

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Iqbal Hussain, "Electric & Hybrid Vehicles – Design Fundamentals", 2nd Edition, CRC Press, 2011.
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2012.

REFERENCES

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2001.
3. http://nptel.ac.in/courses/108103009/

19ME17E	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Identify the fluid power symbols and select suitable fluid for different applications. (K2)
CO2: Choose suitable fluid power driving system and actuators for any given application. (K3)
CO3: Select appropriate fluid power control elements for simple fluid power systems. (K2)
CO4: Describe the working of pneumatics components and circuits. (K2)
CO5: Design and develop the fluid power circuit for any specific applications. (K3)

UNIT I FUNDAMENTALS OF FLUID POWER SYSTEMS 9

Introduction to Fluid power systems - Types, Advantages and Applications. Properties of hydraulic fluids - General types of fluids - Basics of Hydraulics system. Applications of Pascal's Law - Laminar and Turbulent flow - Reynold's number - Darcy Weisbach equation - Losses in pipe, valves and fittings - Problems - Case studies on simple hydraulic systems.

UNIT II HYDRAULIC SYSTEM AND COMPONENTS 9

Sources of Hydraulic Power - Pumping theory - Pump classification - Construction and working of Gear, Vane and Piston pumps - Performance. Fluid Power Actuators- Linear actuators - Single acting, Double acting, special cylinders like tandem, Rod less, Telescopic. Cushioning mechanism in linear actuators. Rotary actuators - Gear, Vane and Piston motors. ISO symbols of Fluid power components.

UNIT III CONTROL COMPONENTS 9

Types of control components - Direction control valves - Shuttle valve - check valve - pressure control valve - counterbalance valves - pressure reducing valve - sequence valve. Flow control valves - fixed and adjustable, solenoid valves, relays. Accumulators and Intensifiers - types - working principle - sizing of accumulators - accumulators circuits, pressure intensifier - applications.

UNIT IV PNEUMATIC SYSTEM COMPONENTS AND SERVO SYSTEMS 9

Properties of air - Pneumatic components - Compressors - Filter, Regulator, and Lubricator (FRL) unit - air control valves, quick exhaust valves, and pneumatic actuators. Servo systems - Hydromechanical servo systems, Electro-hydraulic servo systems and proportional valves. Introduction to PLC - ladder diagrams - applications of PLC in fluid power control - case studies on simple pneumatic systems.

UNIT V DESIGN OF FLUID POWER CIRCUITS 9

Fluid Power Circuit Design, Circuits for acceleration and deceleration, synchronizing circuit, regenerative circuits, feed circuits, sequencing circuits, fail-safe circuits, Pneumo-hydraulic circuit, Sequential circuit design for simple applications using cascade method. Applications in Assembly, Metalworking, materials handling and plastics working.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Anthony Esposito, Fluid Power with Applications, Pearson Education New Delhi, 2013.
2. Andrew Parr, Hydraulics and Pneumatics, Jaico Publishing House, 2013.

REFERENCES

1. Majumdar SR, Pneumatic Systems - Principles and Maintenance, Tata McGraw Hill, 2006.
2. Majumdar SR, Oil Hydraulic Systems - Principles and Maintenance, Tata McGraw-Hill, 2006.
3. Illango S and Soundararajan V, Introduction to Hydraulics and Pneumatics Prentice Hall of India, 2011.
4. John S Cundiff, Fluid Power Circuits and Controls - Fundamentals & Applications, CRC Press, 2019.
5. James L Johnson, Introduction to Fluid Power, Cengage Learning, 2002.
6. William Bolton, Pneumatic & Hydraulic Systems, Elsevier Science and Technology, 1997.

19ME18E DESIGN OF JIGS, FIXTURES AND PRESS TOOLS	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Select locating and clamping devices for a given machining operation. (K3)

CO2: Design jig and fixture for a simple component to perform simple operation. (K3)

CO3: Estimate press capacity and prepare strip layout. (K3)
CO4: Design and develop bending and drawing dies. (K3)
CO5: Design a blanking and piercing die. (K3)

UNIT I LOCATING AND CLAMPING PRINCIPLES 9

Principles of location - Locating methods and devices. Principles of clamping - Clamping elements with mechanical, pneumatic and hydraulic actuations. Standard parts - Drill bushes- Tolerances and error analysis. Design considerations for Jigs and Fixtures.

UNIT II JIGS AND FIXTURES 9

Types of Jigs - post, turnover, channel, latch, box, pot, angular post jigs - Indexing jigs. General principles of milling, Lathe, boring, broaching and grinding fixtures - Assembly, Inspection and Welding fixtures - Modular fixtures- Quick change fixtures. Design of jigs and fixtures for given component.

UNIT III ELEMENTS OF PRESS TOOLS 9

Press Working Terminologies - operations - Types of presses - press accessories - Computation of press capacity - Strip layout - Centre of pressure - Material Utilization - Shearing action -Clearances - Press Work Materials - Functions of various elements of dies - Die Block - Punch holder, die set, guide plates - Stops - Strippers - Pilots - Selection of Standard parts.

UNIT IV BENDING AND DRAWING DIES 9

Blank development for the above operations - Types of bending dies - Press capacity - spring back - knockouts - pressure pads - ejectors - variables affecting metal flow in drawing operations - draw die inserts - Design and development of bending and drawing dies.

UNIT V BLANKING DIES 9

Design and development of blanking, piercing, compound and progressive dies. Recent trends in tool design - computer assisted metal forming.

L:45; TOTAL:45 PERIODS

Note: ***Use of P S G Design Data Book is permitted in the End Semester Examination***

TEXT BOOKS

1. Joshi P H, “Jigs and Fixtures”, Tata McGraw Hill, 3rd Edition, New Delhi, 2010.
2. Donaldson, Lecain and Goold “Tool Design”, Tata McGraw Hill, 4th Edition, 2012.

REFERENCES

1. Design Data Hand Book, PSG College of Technology, Coimbatore, 2020.
2. Hoffman, “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
3. Venkataraman, K, “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2015.
4. Kempster, “Jigs and Fixture Design”, Hodder and Stoughton, 3rd Edition 1987.
5. Joshi P H, “Press Tools - Design and Construction”, Wheels publishing, 2008.
6. ASTME Fundamentals of Tool Design, Prentice Hall of India, 1984.

19ME19E	MECHATRONICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the importance of mechatronics systems and its applications. (K2)
CO2: Discuss types and functions of various actuators and sensorssystems. (K2)
CO3: Explain the signal conditioning and DAQ systems. (K2)
CO4: Interpret actual models of simple systems and controllers. (K2)
CO5: Describe the significance of PLC and micro mechatronics systems for automation. (K2)

UNIT I INTRODUCTION TO MECHATRONICS **9**

Introduction - Definition - need - elements. Traditional and Mechatronics Design process - Design Parameters - Advanced approaches in Mechatronics for Industrial applications. Continuous monitoring system - Case study on the application of Mechatronics system in process automation, manufacturing, product design and testing.

UNIT II ACTUATORS AND SENSORS **9**

Introduction to pneumatic and hydraulic systems - over view - valves and its types - selection. electro-pneumatic actuator - solenoids. Electric motors - DC motors, AC motors, single phase motor - 3-phase motor - induction motor - synchronous motor - stepper motors.

Importance of sensors and transducers - classification - static and dynamic characteristics - Measurements - displacement, strain, position, velocity, flow, pressure, temperature, humidity, vibration, liquid level and light sensors - Case study on selection of sensors for specific applications.

UNIT III SIGNAL CONDITIONING AND DATA ACQUISITION SYSTEM **9**

Analog Signal Conditioning - Op-Amp Circuits - Principles of Analog to Digital Converters (DAC) and Digital to analog converters (ADCs) - Multiplexer and De-multiplexer. Overview of Data Acquisition System (DAQ) - Analog and Digital Data Acquisition Systems. Overview of Data Logger - Functional block diagram, use of Data Acquisition System in industries.

UNIT IV SYSTEM MODELS AND CONTROLLERS **9**

Building blocks for simple mechanical, electrical, fluid and thermal systems - Rotational transnational systems - Electro mechanical systems. Continuous and discrete process controllers - Control modes - introduction - Two-step, Proportional, Derivative, Integral mode and PID controllers. Applications of controllers for process monitoring activities.

UNIT V PLC and MICRO MECHATRONIC SYSTEMS **9**

Introduction to Programmable Logic Controllers (PLC)-Basic Structure - Input / Output Processing - Programming - Mnemonics - Timers, Internal relays and counters - Shift

Registers - Master and Jump Controls - Data Handling - Analogs Input/Output - Applications. Micro-Mechatronics elements, Micro-sensor - Micro actuator - characteristics, Applications of Micro Mechatronics systems.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Bolton, W., "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", 7th Edition, Pearson Education, 2018.
2. NitaigourPremchandMahalik, "Mechatronics - Principles, Concepts and Applications", Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 2006.

REFERENCES

1. Alciatore, D.G. and Histand, M.B., Introduction to Mechatronics and Measurement Systems, 4th Edition, McGraw Hill, 2012.
2. David G Alciatore and Michael B Histand, "Introduction to Mechatronics and Measurement Systems", Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 2012.
3. Doeblin E O, "Measurement Systems", 5th Edition, McGraw Hill, 2008.

19ME20E	INDUSTRIAL ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the basic configurations of robots (K2)
CO2: Discuss the robot drive system and the forward and inverse kinematics (K2)
CO3: Explain the working of sensors and Machine Vision system (K2)
CO4: Write simple robot programming (K2)
CO5: Discuss the use of robot in various fields (K2)

UNIT I INTRODUCTION **9**

Robot - Definition - Robot Anatomy - Co-ordinate Systems, Work Envelope - Types - Classification. Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions - Need for Robots - Different Applications.

UNIT II COMPONENTS AND OPERATIONS **9**

Basic control system concepts - control system analysis - robot actuation and feedback, Manipulators - Coordinate transformation - Brief of Robot dynamics. Types of end effectors - Grippers - Tools as end effectors.

UNIT III SENSORS AND MACHINE VISION **9**

Types of sensors - Range sensors - Proximity sensors - Touch sensors - Force and Torque sensors- applications. Introduction to Machine vision - Sensing and digitizing - Image processing and analysis.

UNIT IV ROBOT PROGRAMMING 9

Methods - languages - Capabilities and limitation - Artificial intelligence (AI) - Knowledge representation - Search techniques - simple programming.

UNIT V INDUSTRIAL APPLICATIONS 9

Influence of robots in industry 4.0 - Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading - CIM - Hostile and remote environments.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, Industrial Robotics: Technology, Programming and Applications, 2nd Edition, Tata McGraw Hill, 2012.
2. Mark R. Miller "Robots and Robotics" McGraw Hill International Edition, 2018.

REFERENCES

1. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger N. Nagel, Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications" McGraw Hill Education; 2nd Edition, 2017.
2. S K. Saha "Introduction to Robotics" 2nd Edition, 2014.
3. Ashitava Ghosal, "Robotics fundamental concepts and Analysis", oxford university press, 2006.

19ME21E	ADVANCED MODELING TECHNIQUES	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon successful completion of this course the students will be able to

CO1: Apply the principles and concepts of Geometric modeling, solid modeling and assembly. (K3)

CO2: Apply advanced modeling and computational tools for complex mechanical parts. (K3)

CO3: Produce detailed exploded assembly views with Bill of Materials. (K3)

CO4: Execute weldment and sheet metal CAD drawings for mechanical engineering applications in the current industrial practice. (K3)

CO5: Describe the fundamentals of GD &T. (K2)

UNIT I MODELING CORE CONCEPTS 12

Planes and Axis - 2D Sketch - Line, Rectangle, arcs, relations, Constrained sketch. Part modeling - Extrude, Revolve, Sweep, Loft, Rib, Fillet, Chamfer, Shells, Mirroring, Patterns, drafts, custom properties.

Assembly constraints - Mates, Smart mates, Interference, Collision, Dynamic clearance, Exploding assembly.

UNIT II ADVANCED PART MODELING AND ASSEMBLY 12

3D Sketch - Parabola, conic, splines, derived sketches. Advanced part modeling - Flex, Bending, Twisting, Tapering & Stretching, Splitting, Multi body, Configurations. Assembly - Flexible sub assembly, Path, Linear coupler, Gear, Cam, Screw, Limit and Hinge mates, Assembly Configurations.

UNIT III ADVANCED DRAFTING AND ANIMATIONS 12

Different views - Model, projection, section, detail, broken, exploded. Dimensions - ordinate, driving, baseline, annotations, balloons, Bill of materials, tables, Tolerances. Animations -walkthrough videos, Photo view, Rendering.

UNIT IV WELDMENT AND SHEET METAL MODELING 12

Weldment - Structural Members, Trim, Extend, Gusset end caps, Weld beads, Cut List, Sub-weldment, Custom profiles. Sheet Metal - Cone, Cylinder, Lofts, Base Flange, Edge Flange, Swept flange, Mitre flange, sketched bend, Jog, Hem. Surfacing - Spline, boundary surface, knit.

UNIT V GEOMETRIC DIMENSIONING AND TOLERANCING 12

Engineering drawing and tolerance - Limits, fits and Tolerance - Tolerance symbols and terms - rules and concepts of GD&T - significance of GD&T - MMC, LMC - datum - Form - Orientation - profile - Runout.

L:30; P:30; TOTAL:60 PERIODS

Note: The End Semester Examination will be conducted in computer aided design laboratory

REFERENCES

1. Ibrahim Zeid, “CAD/CAM, Theory and Practice”, Tata Mc Graw Hill, 2010
2. Donald Hearn, “Computer Graphics”- Pearson Education Ltd, 2nd Edition, 2011.
3. Matt Lombard, Mastering Solidworks, 2018.
4. Alex Krulikowsi, Fundamentals of Geometric Dimensioning and Tolerancing, 2nd Edition, Delmar publications, 2012.
5. Standards for dimensioning and tolerancing - ASME Y 14.5, 2009
6. James D Meadows, GD&T Application, analysis and Measurements, ASME Press 2009.

19ME22E	PIPING DESIGN ENGINEERING	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Apply the fundamental principles for designing pipes and creating engineering drawings. (K2)

CO2: Explain the working principle of piping components and design of pipes for various piping codes and standards. (K2)

CO3: Analyze the stresses induced in the pipes under static loading condition. (K4)

CO4: Design pipes and pipe support structures considering weld reinforcement and stress intensifications. (K3)
CO5: Predict mathematically the behavior of pipes under dynamic conditions. (K4)

UNIT I FUNDAMENTALS 12

Engineering drawing fundamentals - Piping drawings - P and ID - Plot Plan - Layout - Mechanical Design fundamentals - Pressure, Temperature, Flow rates, stress, strain, theory of failure, Young's modulus, moment of inertia, section modulus and radius of gyration. Dynamic loads - Harmonic, Modal, Spectrum, frequencies.

UNIT II PIPING ELEMENTS AND MATERIALS 12

Introduction to piping - Piping Components - Pipe, Fittings, Flanges, Gaskets and Bolting - Valves - Isolation, Regulation, Non-return and Special purpose. Piping Materials - Piping Codes and Standards - Pipe Sizing, Diameter and Pressure drop calculations.

UNIT III PIPING SUPPORTS AND STATIC STRESS ANALYSIS 12

Piping Supports - Restraints and hangers - Variable and Constant load spring hangers - selection design methodologies - Stress analysis introduction - Method of analysis -Static Stress analysis exercises - Piping Flexibility - Code Stress requirement.

UNIT IV WRC AND SIF IN PIPING 12

Welding reinforcement calculations - Nozzle design - Stress intensification at elbows, tees and branch - Structure basics - Piping supporting structure modeling.

UNIT V DYNAMIC ANALYSIS 12

Wind and Seismic analysis - Damping - Lumped Mass - Steady state vibration and harmonic analysis - Time history Analysis.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Mohinder L Nayyar, "Piping Handbook", McGraw Hill Handbook, 7thEdition, 2000.
2. George A Antaki, "Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair", CRC Press, 2003.

REFERENCES

1. "Power and Process Piping Standards" ASME B 31.1 & B 31.3, 2012.
2. Kellogg M W, "Design of Piping Systems", John Wiley & Sons, 2019.
3. Liang-Chuan Peng and Tsen-Loong Peng, "Pipe Stress Engineering", ASME Press, New York, 2009.

19ME23E	VIBRATION CONTROL	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the basic concepts of vibration and vibration control. (K2)
CO2: Analyze the vibration generation mechanism. (K3)
CO3: Explain the passive vibration control techniques. (K2)
CO4: Discuss the active vibration control methods. (K2)
CO5: Articulate the vibration measurement and analysis techniques. (K2)

UNIT I BASIC CONCEPTS OF VIBRATION 9

Basic Concepts: Review of free and forced vibrations with and without damping; Free and forced vibration of single, two and multi-degree of freedom systems with and without viscous damping. Basics of Vibration Control: reduction at source, Active feedback control, vibration isolation.

UNIT II VIBRATION GENERATION MECHANISM 9

Vibration generation mechanisms: Source classification, self-excited vibration, flow induced vibration, field balancing of rigid rotors/flexible rotors and damping models and measures, Design consideration of material selection.

UNIT III PASSIVE VIBRATION CONTROL 9

Basics, design of absorber, absorber with ideal spring, shock absorber, isolators with stiffness and damping.

UNIT IV ACTIVE VIBRATION CONTROL 9

Basics, Piezoelectric materials, electro-rheological fluids, magneto-rheological fluids, Electro- Magneto strictive Materials in Vibration Control, shape memory alloys and electro-magnetic materials.

UNIT V VIBRATION MEASUREMENT 9

Introduction -Transducers - Vibration Pickups - Frequency - Measuring Instruments - Signal Analysis: FFT analysis and filters- Machine condition Monitoring and Diagnosis.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Singiresu S.Rao, “Mechanical Vibrations”, 6th Edition, Pearson Education, 2018.
2. Inman DJ, “Vibration and Control”, John Wiley & Sons Inc, 2014.

REFERENCES

1. Grover. G.K., “Mechanical Vibrations”, 8th Edition, Nem Chand and Bros., 2020.
2. Balakumar Balachandran and Edward B. Magrab, “Fundamentals of Vibrations”, 1st Editon, Cengage Learning, 2014.
3. Ambedkar A.G, “Mechanical Vibrations and Noise Engineering”, Eastern Economy Edition, 2006
4. Tamadonni S & Graham S. Kelly, “Mechanical Vibrations”, Schaum’s outline Series, Mc-Graw Hill Inc, 2011.

19ME24E	VEHICLE SYSTEMS DESIGN	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: Discuss the importance of aerodynamic factors on vehicle body design. (K2)
CO 2: Explain the role of ergonomics and vibration control in automobile design. (K2)
CO 3: Discuss the design criteria of chassis and suspension system. (K2)
CO 4: Explain the design considerations for braking and transmission systems. (K2)
CO 5: Discuss failure analysis and its importance in vehicle design. (K2)

UNIT I BODY DESIGN 9

Aerodynamics - Aerodynamic forces - Drag - Drag reduction - Stability and cross-winds - Noise - Under hood ventilation - Cabin ventilation - Wind tunnel testing - Computational fluid dynamics. Recent trends in automotive safety systems - Safety regulations and testing.

UNIT II HUMAN COMFORT IN VEHICLE DESIGN 9

Occupant accommodation - Ergonomics - Eight fundamental fallacies - Ergonomics methods and tools. Vibration control - Fundamentals of acoustics - Human response to sound - Sound measurement - Automotive noise criteria - noise sources - control techniques and Standards.

UNIT III CHASSIS AND SUSPENSION DESIGN 9

Load case, introduction - Chassis types, introduction - Vehicle suspension - Factors affecting design - Definitions and terminology - Mobility of suspension mechanisms - Kinematic analysis - Anti-squat and Anti-pitch suspension geometry- Roll centre analysis - Force analysis.

UNIT IV TRANSMISSION AND BRAKING SYSTEM DESIGN 9

Engine Characteristics - Vehicle's power requirement - manual gearbox - automatic transmission - Continuously variable transmissions. Fundamentals of braking - Legislation - Brake proportioning and adhesion utilization - design of brake materials.

UNIT V FAILURE PREVENTION AND CRASHWORTHINESS 9

Aspects of failures - endurance and durability - Testing and failure prediction - automotive failures Accident and injury analysis - Crashworthiness - Vehicle impacts: general dynamics - crush characteristics - Structural collapse.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Julian Happian-Smith, "An Introduction to Modern Vehicle Design", Reed Educational and Professional Publishing Limited, 2012.

REFERENCES

1. Vivek D Bhise, "Ergonomics in the Automotive Design Process", CRC Press, 2015.
2. Donald E Malen, "Fundamentals of Automobile Body Structure Design", SAE

International, 2011.
3. Jan PN orbye, “Car Design: Structure & Architecture”, Tab Books, 2011.
4. Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, SAE International, 2020.
5. Lorenzo Morello et.al, “The Automotive Body; Volume II: System Design”, Springer, New York, 2011.

19ME25E	INDUSTRIAL TRIBOLOGY	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Discuss the basic concepts of Tribology in detail. (K2)

CO2: Discuss about the fundamental concepts and different mechanism involved in friction and wear. (K2)

CO3: Discuss the basic principles of hydrodynamic lubrication and the influence of various operating parameters on the thin film. (K2)

CO4: Discuss the basic principles of hydrostatic lubrication and the influence of various operating parameters on the thick film. (K2)

CO5: Select suitable surface modification methods based on the bearing materials. (K2)

UNIT I INTRODUCTION TO TRIBOLOGY 12

Introduction - Surface topography - Tribology in design - Tribology in industry - economic aspects of Tribology - lubrication - properties of lubricants - types of additives - extreme pressure lubricants - Tribology in condition monitoring - oil analysis.

UNIT II FRICTION AND WEAR 12

Friction - Laws of friction - types of Friction - Causes of friction - Friction Measurement- Theories of Friction - effect of surface preparation. Wear - Mechanism - Wear between solids and liquids - Factors affecting wear -Measurement of wear - Theories of Wear - Methods to Control Friction and Wear.

UNIT III HYDRODYNAMIC LUBRICATION 12

Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold’s equation, infinitely long journal bearing, infinitely short journal bearing and finite bearing. Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, centre of pressure and friction in tilting pad thrust bearing.

UNIT IV HYDROSTATIC LUBRICATION 12

Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses and optimum design of step bearing. Compensators and their actions. Squeeze film lubrication: introduction, circular and rectangular plates approaching a plane.

UNIT V SURFACE ENGINEERING 12

Concept of Wear and Corrosion resistance - Diffusion, coating, electro and electro less plating, hot deep coating, metal spraying, cladding, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Bharat Bhushan, "Introduction to Tribology", John Wiley & Sons Ltd, Publication, 2nd Edition, USA, 2013.
2. Mehtha NK, "Machine Tool Design and Numerical Control", Tata Mc-GrawHill, 3rd Edition, 2017.

REFERENCES

1. Gwidon Stachowiak and Andrew W Batchelor, "Engineering Tribology", Elsevier International Publishing, Australia, 4th Edition, 2013.
2. Michael M Khonsari and Richard Booser E "Applied Tribology: Bearing Design and Lubrication", John wiley& Sons Ltd Publication, 3rd Edition, USA, 2017.
3. Giovanni Straffelini, "Friction and Wear: Methodologies for Design and Control-Springer Tracts in Mechanical Engineering", Springer International Publishing, Switherland, 2015.
4. Ghosh M K, Majumdar B C, Mihir Sarangi, "Fundamentals of Fluid Film Lubrication", McGraw Hill Education (India) Pvt. Ltd, New Delhi, 1stEdition, 2013.

19ME26E	NEW PRODUCT DEVELOPMENT	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Discuss the basic principles of generic development process and need analysis (K2)

CO2: Explain the process of concept selection for new product design and development (K2).

CO3: Summarize various aspects in detail design (K2)

CO4: Comprehend the principles of design validation and prototyping techniques (K2)

CO5: Interpret the concepts of economics principles and project management practices (K2)

UNIT I PRODUCT DEVELOPMENT AND NEED ANALYSIS 12

Introduction - A Generic Development Process - Field and Market analysis - Data collection techniques - Analysis of Data, PESTEL analysis - Identifying Customer Needs - House of Quality for Specifications - Establishing Target Specifications - Setting the Final Specifications.

UNIT II CONCEPT GENERATION AND EVALUATION 12

Concept generation activities - Pugh concept selection method: Concept screening; Concept scoring - Concept testing - Concepts for smart systems - Value Analysis.

UNIT III EMBODIMENT DESIGN 12

System level Design and issues - Architecture of Product - Sizing of Parts - Selection of materials using Bubble chart - Selection of Manufacturing Processes - Design for Manufacturing - Design for Assembly - Design for Ergonomics - Virtual Manikins - Importance of Tolerances - Detail Design and Bill of Materials.

UNIT IV DESIGN VALIDATION AND PROTOTYPING 12

Prototyping techniques - Additive Manufacturing - Metal Additive Manufacturing techniques - Virtual Prototyping using FEA -Topology Optimization - Generative Design.

UNIT V COST ANALYSIS AND PRODUCT LEGALITY 12

Product Development Economics: Economic Analysis Process - Managing Projects: Protecting intellectual property - Patents, Trade mark and Copy right.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition, 5th Edition, 2012.
2. Karl T Ulrich, Steven D Eppinger, Maria C Yang, “Product Design and Development”, 7th Edition, Tata McGraw-Hill Education, 2020.

REFERENCES

1. Kevin Otto, Kristin Wood, “Product Design”, Indian Reprint, Pearson Education, 2007.
2. Clive L.Dym, Patrick Little, “Engineering Design: A Project-based Introduction”, 4th Edition, John Wiley & Sons, 2013.
3. S.P. Jain & K.L. Narang, “Advanced Cost Accounting”, Kalyani Publishers, 2017.

19ME27E DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the general principles of manufacturability (K2)
CO2: Understand the factors influencing form design (K2)
CO3: facilitate machining using various design features (K2)
CO4: redesign of castings based on Parting line considerations (K2)
CO5: know the concepts to design various components for the environmental concern (K2)

UNIT I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits - Datum features - Tolerance stacks.

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machining area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly - Product design for manual assembly - Product design for automatic robotic assembly.

UNIT IV DESIGN FOR CASTING AND WELDING 9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design – Design aspects for the welded components and assembly.

UNIT V DESIGN FOR THE ENVIRONMENT 9

Introduction - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - application. Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability - Design for manufacture - Design for energy efficiency - Design to regulations and standards.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Harry Peck, Designing for manufacture, Pitman, 1973.
2. Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

REFERENCES

1. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
2. Fixel, J. Design for the Environment McGraw Hill., 2011.
3. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 2001.
5. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
6. Boothroyd, G, Marcel Dekker, "Design for Assembly Automation and Product Design", New York, 1980.

19ME28E	MEMS DEVICES - DESIGN AND FABRICATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: Explain the fundamentals of MEMS and its applications (K2).

CO 2: Discuss the working of various sensors and actuators (K2).

CO 3: Explain various micro-machining processes (K2).

CO 4: Explain MEMS materials & fabrication methods (K2).

CO 5: Discuss applications of MEMS technology in various fields (K2).

UNIT I INTRODUCTION 8

Introduction to MEMS - Micro sensors, Micro actuators - microelectronics fabrication-micromachining - micro fluids- Mechanical MEMS, Magnetic MEMS, Thermal MEMS, RF MEMS - Nanotechnology - MEMS packaging and design considerations - Micro instrumentation- Applications and advantages of MEMS.

UNIT II SENSORS AND ACTUATORS 10

Principles of sensing and actuation - beam and cantilever - microplates - strain and pressure measurements-piezoelectric materials for MEMS, MEMS gyroscopes, shear-mode piezo-actuator, Applications. Interdigitated Finger capacitor - Comb drive devices - Micro Grippers - Micro Motors. Thermal Sensing and Actuation - Thermistors - Thermal couples - Thermal resistors - Thermal Bi-morph - Applications. Magnetic Actuators - Micro magnetic components - Use of Shape Memory Alloys in MEMS. Piezo-resistive and Piezoelectric sensors and actuators - piezoelectric effects - piezoelectric materials - Applications.

UNIT III MICRO MACHINING 9

Silicon Anisotropic Etching- Anisotrophic Wet Etching - Dry Etching of Silicon -Plasma Etching -Deep Reaction Ion Etching (DRIE) - Isotropic Wet Etching -Gas Phase Etchants-Case Studies-Basic surface micro machining processes -Structural and Sacrificial Materials -Acceleration of sacrificial Etch-Striction and Antistriction methods-LIGA Process-Assembly of 3D MEMS -Foundry process.

UNIT IV MEMS MATERIALS AND FABRICATION METHODS 9

MEMS Materials Properties, Microelectronic Technology for MEMS, Micromachining Process - Etch Stop Techniques and Microstructure, Surface and Quartz Micromachining, fabrication of Micro-machined Microstructure, Micro-stereo-lithography.

UNIT V APPLICATIONS OF MEMS TECHNOLOGY 9

Wafer Bonding, Chemical Mechanical Polishing, Bonding & IC Packaging of MEMS, Micro Scaling Considerations, Applications in Automotive Industry, Mechanical, Optical, Biomedical & Chemical industries - Case studies.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. NitaigourPremchandMahalik, "MEMS", McGraw Hill Education (India) Pvt Ltd, 11th reprint, 2016.
3. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2007.
4. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata Mc-Graw Hill, New Delhi, 2002.

REFERENCES

1. Nadim Maluf, "An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2001.
3. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, "Micro Sensors MEMS and Smart Devices", John Wiley & Son Ltd., 2002.
4. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.

19ME29E	**APPLIED NANO TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the basic concept of nanotechnology. (K2)

CO2: Discuss synthesis of nano materials by different methods. (K2)

CO3: Demonstrate the various imaging technique to characterize nano materials. (K2)

CO4: Select nanomaterials for functional applications (K2)

CO5: Discuss the application of nanomaterials for heat transfer and energy storage (K2)

UNIT I INTRODUCTION TO NANO MATERIALS 9

Background to Nanoscale Science and Technology, fundamental physics and chemistry of nano materials, Effect of nano dimension on materials properties. Classification of nano materials - properties and applications, Quantum confinement effects with examples.

UNIT II SYNTHESIS OF NANOMATERIALS 9

High energy ball mill — Mechanochemical process – Arc plasma - Sol gel processing - Spray pyrolysis - Electro spraying and spin coating -Vapour deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE) - Pulsed laser deposition, Magnetron sputtering.

UNIT III CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy – modes of operation, Resolution and contrast enhancement, TEM- modes of operation- Specimen preparation, HRTEM in

nanostructures, AFM- Different modes of operation – contact and non-contact mode - Imaging and manipulation of samples in air/liquid environments, Surface and molecular manipulation using scanning tunnelling microscopy, Nanoindentation.

UNIT IV PROCESSING OF NANOCOMPOSITE FOR FUNCTIONAL APPLICATIONS **9**

Bulk metal and ceramic nanocomposites, Processing of nanocomposites: Powder metallurgy method, Pressure Infiltration technique, ultrasonic based stir Casting, Processing of polymer nanocomposites, Nano composites for hard coatings, DLC coating. Carbon nanotube-based nanocomposites, Functional Low dimensional Nanocomposite.

UNIT V NANOMATERIALS FOR ENERGY STORAGE AND HEAT TRANSFER APPLICATION **9**

Heat Transfer Fluids, Nanocomposites, Nanomaterials for energy storage, Solar collector, energy Harvesting, Fuel cell and hydrogen storage applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Chattopadhyay K. K and Banerjee A. N, “Introduction to Nanoscience and nanotechnology”, PHI Learning Private Ltd, 2009.
2. Ying Wang and Guozhong Cao, “Nanostructures and Nanomaterials: Synthesis, Properties and Applications”, World Scientific Publishing Ltd, 2nd Revised Edition, 2010

REFERENCES

1. S. Zhang and Nasar Ali, “Nanocomposite Thin Films and Coatings: Processing, Properties and Performance”, Imperial College Press, 2007.
2. Edelstein A.S. and Cammaratra R.C., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1998.
3. Suryanarayana C., “Mechanical alloying and milling”, Marcel Dekker, Inc., New York, 2005.
4. Cao G., “Nanostructures & Nano materials: Synthesis, properties & applications”, Imperial college press, 2004.
5. John Dinardo N, “Nanoscale characterization of surfaces & Interfaces”, Weinheim Cambridge, Wiley-VCH, 2nd Edition, 2008.
6. George J., “Preparation of thin films”, Marcel Dekker, Inc., New York, 2005.

19ME30E	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the fundamentals of composite materials and its classification(K2)

CO2: Describe the knowledge in polymer matrix composites and its processing methods (K2)

CO3: Understand the metal matrix composites and its manufacturing processes (K2)
CO4: Comprehend the ceramic matrix composite and its processing routes. (K2)
CO5: Discuss Mathematical techniques to predict the macroscopic properties of different Laminates. (K2)

UNIT I INTRODUCTION TO COMPOSITE MATERIALS 9

Definition, need –Classification of composite materials – General characteristics – Applications – Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Fibers – Glass, Carbon, Ceramic and Aramid fibers - characteristics of fibers and matrices -Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law - Reduction to Homogeneous Orthotropic Lamina - Rule of mixtures.

UNIT II METAL MATRIX COMPOSITES 9

Characteristics of MMC, various types of metal matrix composites alloy vs. MMC, advantages of MMC, limitations of MMC, Reinforcements – particles – fibres. Effect of reinforcement – volume fraction – rule of mixtures. Manufacturing methods of MMC – powder metallurgy process - diffusion bonding – stir casting –In-situ reactions- applications of MMC in aerospace, automotive industries.

UNIT III POLYMER MATRIX COMPOSITES 9

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibres – ravings –woven fabrics – non woven random mats – various types of fibres. PMC Manufacturing methods - hand lay-up processes – compression moulding – injection moulding - resin transfer moulding – Pultrusion – Filament winding. Laminates- Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. - applications of PMC in aerospace, automotive industries.

UNIT IV CERAMIC MATRIX COMPOSITES 9

Engineering ceramic materials – properties – advantages – limitations – monolithic ceramics - need for CMC – ceramic matrix - various types of ceramic matrix composites- oxide ceramics – non oxide ceramics – aluminium oxide – silicon nitride – reinforcements – particles- fibres- whiskers. Sintering - Hot pressing – Cold isostatic pressing (CIPing) – Hot isostatic pressing (HIPing). Applications of CMC in aerospace, automotive industries.

UNIT V MECHANICS OF COMPOSITES 9

Orthotropic Stiffness matrix (Q_{ij}), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Krishan K. Chawla, "Composite Materials: Engineering and Science", 3rd Edition, Springer, 2013.

2. Mallick, P K, “Fiber-reinforced composites: Materials, manufacturing and Design”, Third Edition, CRC press, 2007.

REFERENCES

1. John Cuppoleeti, “Metal, ceramic and polymeric composites for various uses”, In tech, 2011.
2. Ronald F. Gibson, “Principles of Composite Material Mechanics”, CRC Press; 4th Edition, 2016.
3. Ning Hu, “Composites and their properties”, Intech, 2012.
4. Adel zakiel-sonbati, “Thermoplastic-composite materials”, 2012.
5. T. H. G. Megson “Aircraft Structures for engineering students”, Fourth Edition Butterworth-Heinemann, 2007.

19ME31E	UNCONVENTIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the technological and commercial needs of unconventional machining processes. (K2)

CO2: Describe the applications and process parameters of various mechanical energy-based unconventional machining processes. (K2)

CO3: Explain the influence of EDM process parameters on MRR and surface finish. (K2)

CO4: Discuss the features of chemical energy-based machining processes. (K2)

CO5: Explain various high energy density machining processes and its applications. (K2)

UNIT I OVERVIEW OF UNCONVENTIONAL MACHINING PROCESSES 9

Technological and commercial need, Advantages over conventional machining, classification, performance constraints, selection of UCMP, hybrid processes.

UNIT II MECHANICAL ENERGY BASED PROCESSES 9

Abrasive Jet Machining - Water Jet Machining - Abrasive Water Jet Machining -Ultrasonic Machining - Working Principle - equipment- Process parameters – MRR - Applications.

UNIT III ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining and Wire cut EDM - working Principle - equipment - Power and control Circuits - Process Parameters - Surface Finish, MRR, Tool Wear, Dielectric and Flushing - Applications.

UNIT IV CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining - masks - Etchants - Applications. Principles of ECM-equipment Electrical circuit - Process Parameters - Surface Roughness and MRR - ECG and ECH - Applications.

UNIT V THERMAL ENERGY BASED PROCESSES 9

Laser Beam machining and drilling, plasma Arc machining and Electron Beam Machining Principles - Equipment -Types - Beam control techniques - Applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Gary F Benedict, "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York, 2017.
2. Pandey PC and Shan HS, "Modern Machining Processes" Tata McGraw-Hill, New Delhi, 2008.

REFERENCES

1. Paul De Garmo, Black JT, and Ronald AKohser, "Material and Processes in manufacturing", 8th Edition Prentice Hall of India Pvt. Ltd., New Delhi, 2011.
2. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.
3. Vijay K Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2009.

19ME32E ADDITIVE MANUFACTURING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the development of AM technology and how AM technology propagated into various businesses and developing opportunities. (K2)

CO2: Comprehend the knowledge on process of transforming a concept into the final product in AM technology. (K2)

CO3: Explain the vat polymerization and material extrusion processes and its applications. (K2)

CO4: Comprehend the knowledge on process and applications of powder bed fusion and direct energy deposition. (K2)

CO5: Describe the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes. (K2)

UNIT I INTRODUCTION 9

Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain- Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DFAM) 9

Concepts and Objectives- AM Unique Capabilities: Part Consolidation-Topology Optimization- Lightweight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation -Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation-Customized Design and Fabrication for Medical Applications- Case Studies.

UNIT III VAT POLYMERIZATION AND MATERIAL EXTRUSION 9

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - Advantages- Limitations- Applications. Digital Light Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.

UNIT IV POWDER BED FUSION AND DIRECT ENERGY DEPOSITION 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications.

Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery -Process Parameters -Materials -Benefits -Applications.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 9

Binder Jetting: Three-Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: Multi-jet Modeling- Materials - Process - Benefits. Wire Arc Additive Manufacturing - Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.
2. Ian Gibson, David W.Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015.

REFERENCES

1. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011.
3. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011.
5. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016.

19ME33E	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the construction and working principles of gas and arc welding process. (K2)
CO2: Explain the construction and working principles of resistance welding process. (K2)
CO3: Explain the construction and working principles of various solid-state welding process. (K2)
CO4: Explain the construction and working principles of various special welding processes. (K2)
CO5: Summarize the concepts on weld joint design, weldability and testing of weldments. (K2)

UNIT I GAS AND ARC WELDING PROCESSES 9

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications.

UNIT II RESISTANCE WELDING PROCESSES 9

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations, and applications.

UNIT III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

UNIT IV ADVANCED WELDING PROCESSES 9

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Criteria for weld joint design - Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Little R.L., “Welding and welding Technology”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. Parmer R.S., “Welding Engineering and Technology”, 1st Edition, Khanna Publishers, New Delhi, 2008.
3. Parmer R.S., “Welding Processes and Technology”, Khanna Publishers, New Delhi, 1992.

REFERENCES

1. AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process"
2. Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House.
3. Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge, 1993.
4. Nadkarni S.V. "Modern Arc Welding Technology", Oxford IBH Publishers, 1st Edition, 2005.

19ME34E	MAINTENANCE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the principles of maintenance planning and evaluate the system reliability. (K2)

CO2: Use different maintenance policies for industrial configuration. (K3)

CO3: Utilize state of the art condition monitoring techniques to develop effective maintenance policies. (K3)

CO4: Identify and apply suitable repair method for basic machine elements. (K3)

CO5: Identify and apply a suitable repair method for material handling equipment. (K3)

UNIT I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING 9

Basic Principles of maintenance planning and activity - Importance and benefits of active Maintenance systems -Reliability and machine availability - MTBF, MTTR and MWT - Factors of availability - Maintenance organization - Maintenance economics.

UNIT II MAINTENANCE POLICIES 9

Types of Maintenance policies - Merits and demerits - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - Total productive maintenance.

UNIT III CONDITION MONITORING 9

Condition Monitoring (CM) - Cost comparison with and without CM - On-load and off load testing - Methods and instruments for CM - Temperature sensitive tapes - Pistol thermometers - fluid and vibration monitoring. Ferrography – spectroscopic oil analysis program- wear-debris analysis.

UNIT IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9

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

UNIT V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT 9

Repair methods for Material handling equipments - Equipment records - Job order systems -Use of computers in maintenance.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Srivastava SK, “Industrial Maintenance Management”, S. Chand and Co., 2002.
2. Bhattacharya SN, “Installation, Servicing and Maintenance”, S. Chand and Co., 2013.

REFERENCES

1. White EN, “Maintenance Planning, Control and Documentation”, Gower Press, 1979.
2. Garg M R, “Industrial Maintenance”, S. Chand & Co., 2010.
3. Higgins LR, Keith Mobley “Maintenance Engineering Hand book”, McGraw Hill, 7th Edition, 2014.
4. Davies, “Handbook of Condition Monitoring”, Chapman & Hall, 2012.

19ME35E	NON-DESTRUCTIVE EVALUTION	L	T	P	C
		2	0	2	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Identify the suitable NDT processes for practical application. (K2)
CO2: Discuss liquid penetrant and magnetic particle test for identifying welding defects. (K2)
CO3: Explain the concept for identifying defects. (K2)
CO4: Interpret the radiographic test to identify defects in welded components. (K2)
CO5: Discuss the advanced testing of Non-destructive testing. (K2)

UNIT I INTRODUCTION 12

Introduction non-destructive testing -visual examination-different visual examination aids - selection of NDT processes – detection of manufacturing defects.

UNIT II LIQUID PENETRANT AND MAGNETIC PARTICLE TESTING 12

Physical principle – procedure – penetrant testing materials and methods – sensitivity – advantages and limitations. Physics of magnetism - magnetization techniques – equipment and accessories – demagnetization- advantages and limitations.

UNIT III ULTRASONIC TESTING 12

Fundamentals of ultrasonic waves – inspection methods - equipment - calibration of testing equipment - advantages and limitations.

UNIT IV RADIOGRAPHIC TESTING 12

Geometric exposure principle – radiation sources – radiography techniques – radiation safety - radiographic film processing – radiographic image quality - Interpretation and evaluation of radiographs- advantages and limitations.

UNIT V ADVANCED TESTING 12

Acoustic emission testing – Thermography testing – Eddy current testing – Advanced Ultrasonic testing (TOFD, PAUT) – Advanced radiography (computed radiography & computerized tomography, Digital radiography).

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Parmer R.S, "Welding Engineering and Technology", 2nd Edition, Khanna publishers, Delhi, 2010.

REFERENCES

1. ASM Metals Handbook Vol. 17 – Nondestructive Evaluation and Quality Control, published by ASM, USA
2. R Halmshaw, "Introduction to the Non-Destructive Testing of Welded Joints"- 2nd Edition, Woodhead Publishing, 1997.
3. www.nde-ed.org.

19ME36E QUALITY CONTROL OF WELDED STRUCTURES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Select appropriate welding process for making welded structures for various material combinations. (K2)
CO2: Prepare quality assurance plan for a structure. (K2)
CO3: Estimate the quality of the welded structure and acquires skills for welding inspection. (K2)
CO4: Explain the visual inspection of welded structures. (K2)
CO5: Understand the various codes and standards on welding applications. (K2)

UNIT I WELDING PROCESSES 9

Welding processes – principles and applications - fusion welding – plastic welding – welding defects – advantages and limitations.

UNIT II QUALITY SYSTEM 9

Quality control- quality assurance - manufacturing quality plan - quality control procedures.

UNIT III QUALITY CONTROL 9

Raw material inspection - welding procedure specification- procedure qualification records.

UNIT IV INSPECTION OF WELD JOINTS 9

Inspection - before, during and after welding - mechanical testing – joint categories – welding symbols - visual inspection.

UNIT V WELDING CODES AND STANDARDS 9

Introduction – welding codes and standards - IS 814 weld symbol – IS 7215 Welded assemblies - Testing of materials and weld joints - consumables testing and qualification

as per ASME/AWS.

L:30; P:30; TOTAL:60 PERIODS

TEXT BOOKS

1. Parmer R.S, "Welding Engineering and Technology", 2nd Edition, Khanna publishers, Delhi, 2010.
2. Howard B. Cary; Scott Helzer," Modern Welding Technology", 6th Edition, Pearson, 2005.

REFERENCES

1. Little R.L, "Welding and Welding Technology" - Tata McGraw Hill Publishing Limited, New Delhi, 1989.
2. Larry Jeffus, "Welding and Metal Fabrication", Cengage Learning, 2012.
3. Welding Handbook "Welding Science and Technology" vol.1, Ninth Edition.
4. ASME sec IX 2017.

19ME37E	MACHINE TOOL CONTROL	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the kinematic motions in a machine tool. (K2)
CO2: Explain systems used for achieving required speeds and feeds. (K2)
CO3: Explain the design of Slide ways, spindles and lead screws for reducing friction and achieving high product accuracy. (K2)
CO4: Explain the reasons for chatter in machining and vibrations. (K2)
CO5: Discuss the various quality tests to be performed on the machine tool. (K2)

UNIT I INTRODUCTION TO MACHINE TOOL DRIVES AND MECHANISMS 9

Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission. Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations.

UNIT II MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength Design for Rigidity, Materials for Machine Tool Structures, Machine Tool, Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages.

UNIT III GUIDE WAYS, POWER SCREWS AND SPINDLES 9

Functions and Types of Guide ways, Design of Guide ways, Design of Aerostatic Slide ways, Design of Anti-Friction Guide ways, Combination Guide ways, Design of Power Screws.

UNIT IV DYNAMICS OF MACHINE TOOLS 9

Machine Tool Elastic System, Static and Dynamic Stiffness, Stability Analysis, Machine

Tool Chatter, Damping Characteristics, Damping Methods.

UNIT V CONTROL SYSTEMS IN MACHINE TOOLS 9

Machine tool control systems, Control Systems for Speed and Feed Changing, Adaptive Control Systems.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2017

REFERENCES

1. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.
2. D. K Pal, S. K. Basu, "Design of Machine Tools", 5th Edition. Oxford IBH, 2008.
3. F. Koenigsberger, "Design Principles of Metal-Cutting Machine Tools", Elsevier Science 2013.

19ME38E COMPUTER INTEGRATED MANUFACTURING L T P C
3 0 0 3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the basic concepts of CAD, CAM and computer integrated manufacturing systems (K2)

CO2: Summarize the production planning and control and computerized process planning (K2)

CO3: Differentiate the different coding systems used in group technology (K2)

CO4: Explain the concepts of flexible manufacturing system (FMS) and automated guided vehicle (AGV) system (K2)

CO5: Classify the robots used in industrial applications (K2)

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerised elements of CIM system –Types of production – Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control

Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) – Simple Problems.

UNIT III CELLULAR MANUFACTURING 9

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method – Arranging Machines in a GT cell – Hollier Method – Simple Problems

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9

Types of Flexibility – FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability – Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mikell.P.Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 2018.
2. Radhakrishnan P, SubramanyanS.and Raju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi, 2008.

REFERENCES

1. Gideon Halevi and Roland Weill, “Principles of Process Planning – A Logical Approach”, Chapman and Hall, London, 2012.
2. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 1995.
3. Rao. P, N Tewari &T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2000

19ME39E	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Explain the quality management philosophies and Framework. (K2)

CO2: Discuss the need of customer expectations, employee involvement and Supplier partnership. (K2)

CO3: Analyse the TQM tools and Techniques to improve the product and process Quality. (K3)

CO4: Apply modern tools to improve quality of the product. (K3)

CO5: Describe ISO 9001, Environmental Management Standards and ISO 14001 certification process. (K2)

UNIT I INTRODUCTION 9

Introduction - Need, evolution and definition of quality - Dimensions of manufacturing and service quality - Basic concepts, definition and framework of TQM - Contributions of Deming, Juran and Crosby - Barriers to TQM.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality statements - Customer focus, orientation, satisfaction, complaints and retention - Employee involvement - Motivation, Team and Teamwork, Recognition and Reward, Performance appraisal - Supplier partnership - Partnering, Supplier selection, Supplier Rating - Continuous process improvement - PDSA cycle, 5s and Kaizen.

UNIT III TQM TOOLS AND TECHNIQUES 9

Quality circles - Quality Function Deployment (QFD) - Taguchi quality loss function -TPM - Concepts, improvement needs - Quality cost, types and its analysis techniques - Performance measures.

UNIT IV APPLICATION OF TQM TOOLS AND TECHNIQUES 9

Seven traditional tools of quality - New management tools - Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages and types - criteria for getting Quality awards.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9000-2000 Quality System - Elements, Documentation, Quality auditing- QS 9000 - ISO 14000 - ISO 17025 - Concepts, Requirements and Benefits - Case studies of TQM.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

3. Dale H Besterfiled, “Total Quality Management”, Pearson Education Asia, 3rd Edition, Indian Reprint 2012.
4. Ramachandran S, “Total Quality Management”, Air Walk Publications, 3rd Edition 2014.

REFERENCES

7. James R Evans and William M Lindsay, "The Management and Control of Quality", 6th Edition, Cengage Learning, 2019.
8. Oakland J S, "TQM - Text with Cases", Butterworth - Heinemann Ltd., Oxford, 3rd Edition, 2012.
9. Suganthi L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

19ME40E	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Compute the constraints on the availability of resources, develop a model and give an optimal solution during the given circumstances. (K3)

CO2: Appraise the challenges in the transportation and production problems and furnish a rational solution to maximize the benefits. (K3)

CO3: Plan the purchase/ manufacturing policies, manage the spares/ stocks and meet the customer demands. (K3)

CO4: Analyse the queue discipline and explore the avenues for better customer service. (K3)

CO5: Investigate the nature of the project/ failure and offer methodical assistance towards decision making. (K3)

UNIT I LINEAR PROGRAMMING PROBLEMS 9

OR-Definition - Phases - models, LP problem formulation – Graphical solution, GLPP, Standard and Canonical forms of LPP- simplex methods- Big M, Two phase methods, Alternate optimal solutions, Duality in LP.

UNIT II TRANSPORTATION 9

Transportation problems- Basic feasible solution, Optimal solution By MODI method, Balanced and Unbalanced TP, Degeneracy, Production problems. Assignment problems – Hungarian method Traveling salesman problems - Sequencing models- Johnson algorithm, n job 2 machines, n job 3 machines and n job m machines.

UNIT III INVENTORY CONTROL 9

Types of inventory- Inventory cost - EOQ - Deterministic inventory problems – Purchase andProduction models with and without shortages-EOQ with price breaks - Stochastic inventoryproblems - Multi product problems - Systems of inventory control (P and Q Systems)-Determination of buffer stock and re-order levels - Selective inventory control techniques (ABC, VED, SDE, etc.)

UNIT IV PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Project management: Network logic – Ford-Fulkerson's rule - AON diagram - CPM and PERTtechniques, Critical path and float calculations Replacement models -types of

failures – Gradual failures-replacement of items: Efficiency deteriorates with time, sudden failures- individual and group replacement policies.

UNIT V QUEUING THEORY 9

Queuing system - Characteristics - symbols - Poisson process and exponential distribution –Single server queuing models – Multi-server queuing models, Simulation Monte Carlo technique - Queuing problems.

L:45; TOTAL:45 PERIODS

Note: Use of Normal distribution tables is permitted in the End Semester Examination

TEXT BOOKS

1. Wayne.L.Winston, "Operations research applications and algorithms",4th Edition, Cengagelearning, 2004.
2. Hamdy A Taha, "Operations research an introduction", 10thEdition, PHI/Pearson education, 2017.

REFERENCES

1. Srinivasan G, "Operations research principles and applications", 3rd Edition EEE PHI, 2017.
2. Pannerselvam R, "Operations research", 2nd Edition, PHI, 2009.
3. Ravindran, Phillips and Solberg, "Operations research principles and practice", 2nd Edition, Wiley India, 2007.
4. Sharma J K, "Operations research theory and applications", 5th Edition, Macmillan India, 2013.
5. Premkumar Gupta and D.S.Hira, "Problems in Operations research", S.Chand, 2009.

19ME41E	IMPLEMENTATION OF QUALITY MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO 1: explain the basic concept, terminology, quality control and quality management system. (K2)

CO 2: describe ways of applying quality management in the actual organization. (K2)

CO 3: demonstrate the capability of making quality management system for the industries. (K2)

CO 4: identify the existence or nonexistence of the implemented quality management system. (K2)

CO 5: demonstrate the quality management principles for excellence in industries. (K2)

UNIT I INTRODUCTION 9

Introduction - Definitions of quality, basic concepts - Overview of historical development - Management theory. Statistical quality control - Integrated quality control - Contemporary developments in the field of quality management - The role of quality control in the modern enterprise - Responsibility as a result of poor quality - Quality and standardization.

UNIT II	**QUALITY MANAGEMENT SYSTEM**	**9**

The development path of a series of ISO 9000 standards. Functional scheme - without / with the QMS. Overview of the requirements of ISO 9000, ISO 9001 and ISO 9004. The establishment of a QMS. Prerequisites. Structure of the documentation. Implementation of documented system.

UNIT III	**BUILDING OFQUALITY MANAGEMENT SYSTEM**	**9**

Building of QMS - Commitment to Quality (Policy Document) - Procedures Manual (Process Documents) - Work Instructions (Task Documents) - Risk-based Thinking - Risk Assessment – Improvement - Improvements using through ISO 9001:2015 - Process Improvements -Corrective Action. Tools - Customer feedback - Self-awareness - Failure Mode and Effects Analysis (FMEA).

UNIT IV	**JUDGMENT AND WITNESSING SYSTEM**	**9**

Judgment and witnessing system. Internal judgment - The national system of accreditation - External independent judgment - Horizontal and vertical judgment - Auditor's task - Modes of judgment. Real world Case study - Concluding Remarks (phases, price, terms and benefits).

UNIT V	**QUALITY MANAGEMENT PRINCIPLES FOR EXCELLENCE**	**9**

Quality management systems - Quality control methods - Quality audit and certification of management systems - Sustainable development - Environment management systems - Occupational health and safety management system - Eco-labeling - Total quality management.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Besterfield D. H., "Quality Control", Seventh edition, Pearson College Div; Subsequent edition, New Jersey, 2009.
2. Barrie G Dale, "Managing Quality", Oxford: Blackwell Publishing, 2016.

REFERENCES

1. Evans J. R., Lindsay W. M, "The management and control of quality", South-Western college publishing, USA, 2010.
2. Foster T. S, "Managing quality: An Integrative Approach", Prentice Hall, New Jersey, 2003.
3. Goetsch D. L., Davis S. B., "Quality management. Introduction to TQM for production, processing and services", 4th Edition, Prentice Hall, New Jersey, 2006.

19ME42E	**PRODUCTION AND OPERATIONS MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: outline the role of Production and Operations management in enabling and enhancing a firm's competitive advantages in the dynamic business environment. (K2)
CO2: discuss sufficient knowledge and skills to forecast demand for Production and Service Systems. (K2)
CO3: explain Aggregate Planning strategies and Material Requirement Plan. (K2)
CO4: express analytical skills to calculate capacity requirements and developing capacity alternatives. (K2)
CO5: apply scheduling and Lean Concepts for improving System Performance. (K3)

UNIT I INTRODUCTION 9

Objectives of Operations Management, Scope of Operations Management, Relationship of Operations with other Functional areas, Manufacturing Vs Service sector, Operations Decisionmaking, Phases in Product Design and Development, Product Life Cycle, Process Selection.

UNIT II FORECASTING 9

Need, Determinants of Demand, Demand Patterns, Qualitative Forecasting Methods-Delphitechniques. Market Research, Nominal Group Technique. Quantitative Forecasting methods –Moving Average Methods, Exponential Smoothing Methods, Regression methods, Monitoring and Control of Forecasts, Requirements and Selection of Good forecasting methods.

UNIT III AGGREGATE PLANNING AND MATERIAL REQUIREMENT PLANNING 9

Role of aggregate Product planning, Managerial inputs to Aggregate planning, Pure and Mixedstrategies, Mathematical Models for Aggregate planning – Transportation Method, Linearprogramming Formulation, Linear Decision Rues, Master Production Schedule (MPS), Procedure for developing MPS, MRP -Lot sizing methods – Implementation issues, MRP – II, Introduction to ERP.

UNIT IV CAPACITY MANAGEMENT 9

Measures of capacity, Factors affecting capacity, Capacity Planning, Systematic approach tocapacity planning, Long-term and short-term capacity decisions, Tools for capacity planning,Capacity Requirement Planning- Business Process Outsourcing

UNIT V PRODUCTION ACTIVITY CONTROL AND LEAN MANUFACTURING 9

Objectives and Activities of Production Activity Control -JIT- Kanban- Introduction to Scheduling in different types of Production Systems. Lean Manufacturing - Principles – Activities – Automated Tools and techniques - Case studies.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Panneerselvam. R, Production and operations Management, PHI, 3rd Edition, 2012.

REFERENCES

1. Lee J. Krajewski, Manoj K. Malhotra, Larry P. Ritzman, "Operations Management: Processes and Supply Chains", Pearson Education,11th Edition,2015
2. Norman Gaither, Greg Frazier, "Operations Management", Thomson Learning, 9th Edition, 2006.
3. William J Stevenson, "Operations Management", McGraw Hill,13th Edition, 2018.

19ME43E	VALUE ANALYSIS AND VALUE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Summarise the advantages, applications of value engineering. (K2)
CO2: Outline the function, its approach and evaluation. (K2)
CO3: Explain the job plan and cost reduction program (K2)
CO4: Identify the application of the value analysis value engineering techniques. (K2)
CO5: Illustrate the application of value analysis for cost reduction. (K2)

UNIT I FUNDAMENTALS OF VALUE ENGINEERING 9

Definition of Value - Value Analysis - Value Engineering - Objective - Value Analysis versus Value Engineering –Value Types – How to add value job plan – Technique employed – who will do value engineering – Organizing the value engineering study – Benefits.

UNIT II FUNCTIONAL COST AND ITS EVALUATION 9

Functional cost - Rules for functional definition - Types of functions - Function evaluation process - Methods of function evaluation - matrix technique - MISS technique - Numerical evaluation of functional relationships.

UNIT III VALUE ENGINEERING JOB PLAN 9

Meaning and Importance - Phases of job plan proposed by different value engineering experts - Cost reduction programs - criteria for cost reduction program, Value analysis change proposal.

UNIT IV VALUE ENGINEERING AND VALUE ANALYSIS TECHNIQUES 9

Result Accelerators or New Value Engineering Techniques – Listing - Role of techniques in Value Engineering - Functional analysis system technique - Value Analysis of Management Practice (VAMP) - Steps involved in VAMP - Application of VAMP.

UNIT V APPLICATION OF VALUE ANALYSIS 9

Application of Value analysis in the field of Accounting - Appearance Design - Cost reduction - Quality Control - Comparison of approach of Value analysis & other management techniques.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Lawrence D. Miles, "Techniques of Value Analysis and Engineering", 3rd edition, McGraw Hill Book Company, 2015.

2. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010.

REFERENCES

1. Richard J Park, “Value Engineering – A Plan for Inventions”, St.Lucie Press, London, 2017.
2. Robert B. Stewart, “Fundamentals of Value Methodology”, Xlibris, 2007.

19ME44E	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Explain the fundamentals of supply chain management (K2)
CO2: Outline the functions of logistics management (K2)
CO3: Analyse the network design for efficient distribution (K3)
CO4: Apply inventory management for production and sales forecasting (K3)
CO5: Discuss the issues and recent developments in supply chain and logistics (K2)

UNIT I INTRODUCTION 9

Meaning - Evolution – Fundamentals and Importance - Supply chain strategy - Enablers/ Drivers of Supply Chain Performance - Supply Chain relationships - Green supply chain management.

UNIT II LOGISTICS MANAGEMENT 9

Functions, objectives and solution - Customer Service - Warehousing and Material Storage - Material Handling - Transportation and Packaging – 3PL and 4PL.

UNIT III NETWORK DESIGN 9

Distribution Network Design – Role, Factors Influencing and Options - Value Additions - Models for Facility Location and Capacity allocation - Impact of uncertainty on Network Design - Network Design decisions using Decision trees.

UNIT IV SOURCING AND INVENTORY MANAGEMENT 9

Sourcing – Make Vs. buy decision - Creating World Class Supply base - World Wide Sourcing Inventory Management – managing cycle inventory - Value of information - Bullwhip effect - Coordination in supply chain - Analysing impact of supply chain redesign on the inventory.

UNIT V CURRENT TRENDS 9

E-Business – Framework and Role of Supply Chain in e- business and B2b practices - Supply Chain IT Framework - E-Supply Chains - E – Logistics – eSRM – eLRM – eSCM - Agile Supply Chains - Reverse Logistics - Global Logistics – Real time examples.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Bowersox Donald J, Logistical Management – The Integrated Supply Chain Process" Tata McGraw Hill, 2011.
2. Chopra S and Meindl P, "Supply Chain Management: Strategy, Planning, and Operation", Pearson, 2013.

REFERENCES

1. Donald J. Bowersox, David J. Closs and M. Bixby Cooper, "Supply Chain Logistics Management", Tata McGraw Hill, 2012.
2. Altekar Rahul V, Supply Chain Management-Concept and Cases, Prentice Hall India, 2005.
3. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, "Principles of Supply Chain Management- A Balanced Approach", South-Western, Cengage Learning 2014.
4. NarayaRangarj, G. Raghuram, Mandyam M. Srinivasan, "Supply Chain Management for Competitive Advantage – Concepts and Cases", Tata McGraw Hill, 2009.
5. R.P. Mohanty and S.G. Deshmukh, "Supply Chain Management", Biztantra, 2005.

19ME45E	STATISTICAL QUALITY CONTROL	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply the 7 QC tools in problem solving for continuous improvement. (K3)
CO2: design the control charts for quality control and perform process capability study. (K3)
CO3: understand the concepts of acceptance sampling. (K2)
CO4: discuss the concepts of the reliability and to determine the system reliability. (K2)
CO5: select a suitable method for improving the reliability. (K2)

UNIT I INTRODUCTION: STATISTICAL PROCESS CONTROL 9

Introduction - quality – Inspection- Quality Control and Quality assurance - Life cycle approach to quality costs- Seven SPC tools -Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts and flow chart.

UNIT II PROCESS CONTROL FOR VARIABLES AND ATTRIBUTES 9

Control chart for variables – X chart, R chart and σ chart - Control Chart for Nonconforming - p chart and np chart - Control Charts for Nonconformities - C and U charts - Control Chart for Number of non-conformities per unit - State of control and process out of control identification in charts, pattern study and process capability studies.

UNIT III ACCEPTANCE SAMPLING 9

Importance -Types - Purpose - Components- Procedure - Classification of costs - Cost elements - Overhead expenses - Break-even analysis. The acceptance sampling problem-single sampling plan for attributes-Double, Multiple, and Sequential sampling,

AOQL, LTPD, OC curves.

UNIT IV RELIABILITY CONCEPTS 9

Reliability engineering - fundamentals – failure data analysis, Mean failure rate, Mortality curve- concept of burn –in period, useful life and wear out phase of a system, mean time to failure, mean time between failure, hazard rate –-Maintainability and availability.

UNIT V RELIABLITY ESTIMATION 9

System reliability: Series, Parallel and Mixed configurations, Reliability improvements techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy- fault tree analysis – Product design – Product analysis – Product development – Product life cycles.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Douglas.C.Montgomery, "Introduction to Statistical quality control", John Wiley, 7th Edition, 2013.
2. L.S.Srinath, "Reliability Engineering", East west press, 4thEdition 2011.

REFERENCES

1. Monohar Mahajan, "Statistical Quality Control", Dhanpat Rai & Sons, 2016.
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012
3. Besterfield D.H., "Quality Control", Prentice Hall, 2013.
4. John.S. Oakland. "Statistical process control", Elsevier Butterworth-Heinemann, 2018.

19ME46E	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: explain method study, work measurement tools to improve the process (K2)
CO2: describe a process plan for a given Product (K2)
CO3: Prepare cost elements for a given product (K2)
CO4: estimate the cost of a product based on manufacturing methods (K2)
CO5: estimate the cost for machining a product (K2)

UNIT I WORK STUDY AND ERGONOMICS 9

Method study – Definition – Objectives - Tools and Techniques -Motion economy - Principles - Applications - Work measurement - Standard time – Ergonomics – principles – applications.

UNIT II PROCESS PLANNING 9

Design of a process plan – Selection of production processes, tools and process parameters- Positioning and work holding devices, Selection of inspection devices and tools, Documenting the process plan - Computer-Aided Process Planning (CAPP) – Benefits, Architecture and approaches.

UNIT III INTRODUCTION TO COST ESTIMATION 9

Importance-Types- Purpose- Components-Procedure-Classification of costs - Cost Elements-Overhead expenses - Break-even analysis.

UNIT IV PRODUCTION COST ESTIMATION 9

Estimation of production cost for Casting, Welding and Forging processes – Numerical problems.

UNIT V ESTIMATION OF MACHINING TIME IN DIFFERENT SHOPS 9

Machining time – Estimation - Lathe operations, Drilling, Milling, Shaping and Planning, and Grinding, Cost estimation for machining processes.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Chitale, A. K., and Gupta, R. C., “Product Design and manufacturing”, Prentice Hall of India, New Delhi, 6th Edition 2013.
2. Adithan, M. “Process Planning and Cost Estimation”, New Age International Publishers, 2007.
3. Banga T.R and Sharma.S.C, “Estimating and costing”, Khanna Publishers, New Delhi, 16th Edition, 2011.

REFERENCES

1. Nanua Singh, “System Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons, New York, 2011.
2. S N Chary, “Production and Operations Management” Tata McGraw - Hill Education, 2009.
3. Phillip.FOstwalal and Jairo Munez, "Manufacturing Processes and systems", John Wiley, 9th Edition, 2008.

19ME47E	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the concept of lean manufacturing. (K2)
CO2: understand the various tools and methods of lean manufacturing. (K2)
CO3: explain the various tools for lean manufacturing (LM). (K2)
CO4: study the various concepts in six sigma. (K2)
CO5: describe the above tools to implement LM system in an organization. (K2)

UNIT I INTRODUCTION TO LEAN MANUFACTURING 9

Objectives of lean manufacturing-key principles and implications of lean manufacturing-traditional Vs lean manufacturing.

UNIT II LEAN MANUFACTURING CONCEPTS 9

Value creation and waste elimination-main kinds of waste-pull production-different models of pull production-continuous flow-continuous improvement / Kaizen-worker involvement - cellular layout-administrative lean.

UNIT III LEAN MANUFACTURING TOOLS AND METHODOLOGY 9

Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source-5S principles -preventative maintenance-total quality management-total productive maintenance -changeover/setup time -batch size reduction -production leveling-Value stream mapping-Procedure and principles.

UNIT IV VALUE STREAM MAPPING 9

The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke -Kanban –overall equipment effectiveness - Six Sigma implementation.

UNIT V JUST IN TIME MANUFACTURING AND CASE STUDY 9

Introduction -elements of JIT -uniform production rate -pull versus push method - Kanban system -small lot size -quick, inexpensive set-up -continuous improvement. Optimized production technology.

Toyota Production System (TPS) Tools & Techniques, Application of TPS - Various case studies of implementation of lean manufacturing at industries.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2007.
2. Mikell P. Groover, “Automation, Production Systems and CIM”, Pearson Education, New Delhi, 2016
3. Rother M. and Shook J, “Learning to See: Value Stream Mapping to Add Value and Eliminate Muda”, Lean Enterprise Institute, Brookline, MA. 2003.

REFERENCES

1. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.
2. Richard B Chase F Robert Jacobs and Nicholas J Aquilano, “Operations Management for Competitive Advantage”, 10th Edition, McGraw Hill/Irwin, 2005.
3. Masaaki Sato, “The Toyota Leaders –An Executive Guide”, Vertical Inc, New York, 2008.

19ME48E	INDUSTRIAL SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Appraise the concept of accidents and their prevention. (K2)

CO2: Use the ergonomics to design the work system and to change the human behavior to avoid accidents. (K3)

CO3: Appraise various industrial hazards and their control measures. (K2)

CO4: Select the appropriate fire extinguishing systems for various classes of fire. (K3)

CO5: Use various safety management techniques to promote safety practice and avoid accidents. (K3)

UNIT I ACCIDENT INVESTIGATION, ANALYSIS AND PREVENTION 9

Concept of an Accident, reportable and non-reportable accidents, reporting to statutory authorities. Principles of accident prevention - accident investigation and analysis - Unsafe act and unsafe condition - Domino sequence - cost of accidents - role of safety officer - safety supervisor - safety committee - Factories act and rules related to safety.

UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics - low back pain, risk factors for musculoskeletal disorders in the work place - behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

UNIT III HAZARDS AND THEIR CONTROL 9

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Hazards prevention - Administrative control methods, Engineering control methods- use of personal protective equipment.

UNIT IV FIRE PREVENTION AND PROTECTION 9

Fire triangle-principles of fire extinguishing - various classes of fire - A, B, C, D types of fire extinguishers - Industrial fire protection systems. Sprinklers - Fire hydrants - Alarm and detection systems - other suppression systems - CO_2 system, foam system and DCP system.

UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9

Incident Recall Technique, Disaster Control, Job Safety Analysis, safety survey, safety inspection, safety Audit. Safety training, seminars, conferences, competitions - method of promoting safe practice - creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign - Domestic Safety and Training.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. L M Deshmukh, “Industrial Safety Management”, Tata McGraw-Hill Education, 2010.
2. Charles D. Reese, “Occupational Health and Safety Management: A Practical Approach”, CRC Press, 2018.

REFERENCES

1. Edward Ghali, V. S. Sastri, M. Elboujdaini, “Corrosion Prevention and Protection: Practical Solutions”, John Wiley & Sons, 2007.
2. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
3. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
4. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014.
5. “Accident Prevention Manual for Industrial Operations”, N.S.C. Chicago, 1982.

19ME49E	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Describe the functions and significances of production planning and control. (K2)
CO2: Apply suitable work study methods to improve production process. (K3)
CO3: Prepare the route sheet for manufacturing a product. (K3)
CO4: Analyze the feasible production scheduling method to improve productivity. (K3)
CO5: Discuss the recent techniques in production planning. (K2)

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control - Functions of production control - Types of production environment - Product development and design - Marketing, functional, operational, durability, dependability and aesthetic aspects - Profit consideration - standardization - Break even analysis - Economics of a new product design.

UNIT II WORK STUDY 9

Method study - basic procedure - Micro and memo motion study - work measurement and techniques.

UNIT III PRODUCT AND PROCESS PLANNING 9

Product planning - Extending the original product information - Value analysis - Problems in lack of product planning. Process planning and routing - Pre requisite information needed for process planning - Steps in process planning - Quantity determination in batch production - Machine capacity, balancing - Analysis of process capabilities in a multi-product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems - Loading and scheduling - Master Scheduling - Gantt charts - Basic scheduling problems - Line balancing - Product sequencing - Manufacturing lead

time -Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control - Effect of demand on inventories - Ordering Procedures - Two bin system -Ordering cycle system - ABC analysis - Kanban and JIT - Introduction to computer integrated production planning systems - MRP II and ERP.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Mukhpadyay S K, "Production Planning and Control", PHI Learning Pvt. Ltd., 2015.
2. MartandTelsang, "Industrial Engineering and Production Management", S.Chand and Company, 3rd Revised Edition, 2018.

REFERENCES

1. Upendra Kachru, "Production and operations management - Text and cases", Excel books, 1st Edition, 2009.
2. James B Dilworth, "Operations management - Design, Planning and Control for manufacturing and services", McGraw Hill International Edition, 1992.
3. Kanishka Bedi, "Production and Operations management", Oxford University press, 2nd Edition, 2016.
4. Norman Gaither, Frazier G, "Operations management", Thomson learning, 9th Edition, IE, 2007.
5. Elwood Buffa S, and Rakesh Sarin K, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2007.

19ME50E	ENGINEERING ECONOMICS AND COST ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe basic concepts and terminologies used in engineering economics. (K2)
CO2: Explain the concept of value engineering and find the time value of money. (K2)
CO3: Compare and select alternative methods based on time value of money. (K3)
CO4: Perform replacement and maintenance analysis for different alternatives. (K3)
CO5: Estimate the depreciation and economic life of asset. (K3)

UNIT I INTRODUCTION TO ECONOMICS 9

Introduction to Economics- flow in an economy, law of supply and demand, concept and scope of engineering economics - engineering and economic efficiency - element of costs-break-even analysis- P/V ratio, elementary economic Analysis.

UNIT II VALUE ENGINEERING 9

Make or buy decision, value engineering - function, aims and procedure. Interest formulae and their applications - Time value of money, Single payment compound

amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate.

UNIT III CASH FLOW DIAGRAM 9

Methods of comparison of alternatives - present worth method, Future worth method, Annual equivalent method, rate of return method.

UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and maintenance analysis - types of maintenance and replacement problem, determination of economic life of an asset, replacement of an asset with a new asset - capital recovery with return and concept of challenger and defender, simple probabilistic model for items which fail completely.

UNIT V DEPRECIATION 9

Depreciation, Straight line method, declining balance method - Sum of the years digits method, sinking fund method, Annuity method, service output method -Evaluation of public alternatives - Inflation adjusted decisions - procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

L:45; TOTAL:45 PERIODS

Note: (Use of Interest tables is permitted in the End Semester Examination)

TEXT BOOKS

1. Panneer Selvam R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2nd Edition, 2013.
2. Suma Damodaran, “Managerial economics”, Oxford University press, 2010.

REFERENCES

1. Chan S Park, “Contemporary Engineering Economics”, Prentice Hall of India, 2016.
2. Donald G Newman and Jerome P Lavelle, “Engineering Economics and analysis”, Engg. Press, Texas, 2016.
3. Degarmo EP, Sullivan WG and Canada JR, “Engineering Economy”, Macmillan, New York, 1984.
4. Smith GW, “Engineering Economy”, Lowa State Press, Iowa, 1987.
5. Truettand Truett, “Managerial economics - Analysis, problems & cases”, 8th Edition, Wiley India, 2004.
6. Luke M Froeb / Brian T Mccann, “Managerial Economics - A problem solving approach” Thomson learning, 2017.

19ME51E	E-COMMERCE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Demonstrate the foundations and importance of E-commerce (K2)

CO2: Explain and develop solutions for implementing an ecommerce site. (K2)

CO3: Discuss security, electronic payment technology and requirements for internet-based payments. (K2)

CO4: Summarisethe concept of e-commerce in business applications. (K2)

CO5: Discuss present and future technologies in E-commerce. (K2)

UNIT I INTRODUCTION TO E-COMMERCE 9

Framework – Architecture - Benefits and Impact of e-Commerce - The Anatomy of e-Commerce applications - e-Commerce Consumer applications - e-Commerce Organisation Applications - Consumer Oriented Electronic commerce – Mercantile Process models e-commerce in India - Prospects of e-commerce.

UNIT II BUILDING AN E-COMMERCE WEBSITE, MOBILE SITE AND APPS 9

Systematic approach to build an E-Commerce - Implementation and Maintenance - Optimize Web Performance - Choosing hardware and software – Other E-Commerce Site tools – Developing a Mobile Website and Mobile App.

UNIT III E-COMMERCE SECURITY AND PAYMENT SYSTEMS 9

E-Commerce Security Environment – Security threats in E-Commerce – Technology Solutions – Encryption - Securing Channels of Communication - Protecting Networks - Protecting Servers and Clients – Management Policies - Business Procedure and Public Laws –Electronic, Digital and Virtual Internet Payment System

UNIT IV E-COMMERCE MODELS 9

Business-to-Business–Hubs - Market Places - Business-to-Business Exchange - Business-to-Consumer - Consumer-to-consumer - Business-to-Government - Government-to-Government.

UNIT V FUTURE DIRECTIONS OF E-COMMERCE 9

Software Agents - Technology Behind Software Agents - Frame-work for Software Agent-based e-commerce - m-commerce - m-commerce Architecture - Areas of Potential Growth and Future for m-commerce.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Kenneth C Laudon: “E-commerce”, Pearson Education, Mumbai, 2014.
2. C.S.V.Murthy: “E-Commerce–Concepts, Models & Strategies”, Himalaya Publishing house, Mumbai, 2010.
3. Kamalesh K Bajaj &Debjani Nag: E-Commerce, the Cutting Edge of Business- Tata McGraw- Hill, New Delhi, 2009.

REFERENCES

1. P.T.Joseph: "E-Commerce – An Indian Perspective", 6th Edition, PHI Learning, New Delhi 2019.
2. Gary P Schneider: E Commerce, Cengage Learning, New Delhi, 2014.
3. Christopher Westland J, Theodore H K Clark: "Global Electronic Commerce", Universities Press, Hyderabad, 2009.

19ME52E	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Discuss the challenges in various industrial and need for Industry 4.0 (K2)
CO2: Elaborate the components and support systems involved in Industry 4.0 environment (K2)
CO3: Explain the concept of cloud manufacturing and open manufacturing architecture (K2)
CO4: Discuss the concept of smart factory and machine vision system (K2)
CO5: Summarize the applications of industrial IoT in various domains (K2)

UNIT I INTRODUCTION 9

Introduction- various Industrial Revolutions- Challenges in Manufacturing Industries - need for Industry 4.0 - need for Industrial Big Data and Predictive Analytics for Smart Business Transformation - case studies.

UNIT II COMPONENTS OF INDUSTRY 4.0 9

Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Internet of Services- Smart Devices - Cyber Physical Systems. Robotic Automation and Support System for Industry 4.0. Introduction to Mobile Computing - Augmented Reality and Virtual Reality, Artificial Intelligence – Data collection from sensors - Big Data and Advanced Analysis - case studies.

UNIT III INDUSTRY 4.0 AND CLOUD MANUFACTURING 9

Cyber-physical production systems - Control System as a Service (CSaaS) - Additive Manufacturing for industry 4.0 - Open manufacturing cloud platform for future manufacturing business - Cloud-based decision making in complex engineering environments such as product configuration for manufacturing, process planning, product planning, resource allocation, production planning and Scheduling-examples and case studies.

UNIT IV AUTOMATED MANUFACTURING AND MACHINE VISION 9

Introduction to IT-enabled Smart factories - Smart / intelligent Manufacturing, Overview of CIM, significance of rapid prototyping- - Introduction to Machine Vision - Components- Machine Learning and Applications of Machine Vision in manufacturing/process industries.

UNIT V INDUSTRIAL IoT APPLICATIONS 9

Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries Case studies.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Carlos Toro, Wei Wang, Humza Akhtar, Implementing Industry 4.0: The Model Factory as the Key Enabler for the Future of Manufacturing, Springer, 2021.
2. Anand Nayyar, Akshi Kumar, A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development, Springer, 2020.
3. Carolina Machado, J. Paulo Davim, Industry 4.0-Challenges, Trends, and Solutions in Management and Engineering, CRC press, 2020.

REFERENCES

1. Boris Sokolov, Dmitry Ivanov, Alexandre Dolgui, Scheduling in Industry 4.0 and Cloud Manufacturing, Springer, 2020
2. Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz, Industry 4.0: Industrial Revolution of the 21st Century, Springer, 2019
3. Mohammad Dastbaz, Peter Cochrane, Industry 4.0 and Engineering for a Sustainable Future, Springer, 2019
4. Kaushik Kumar, DivyaZindani, J. Paulo Davim, Industry 4.0: Developments towards the Fourth Industrial Revolution, Springer-Singapore, 2019
5. Max Hoffmann, Smart Agents for the Industry 4.0: Enabling Machine Learning in Industrial Production, Springer FachmedienWiesbaden;Springer Vieweg, 2019
6. Kaushik Kumar, DivyaZindani, J. Paulo Davim, Digital Manufacturing and Assembly Systems in Industry 4.0, CRC Press, 2019.
7. Le, Chung Van; Le, Dac-Nhuong; Nguyen, Nhu Gia; Tromp, Jolanda G, Emerging technologies for health and medicine: virtual reality, augmented reality, artificial intelligence, internet of things, robotics, industry 4.0, John Wiley & Sons, 2018
8. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016

B.E. – MECHANICAL ENGINEERING

ONE CREDIT ELECTIVE COURSES

19ME01L	SHELL AND TUBE HEAT EXCHANGER DESIGN	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Analyse a design based on the information provided for a specific application (K4).

CO2: Determine the size of heat exchanger for a given requirement (K4).

Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperators – Parts description, classification as per Tubular Exchanger Manufacturers Association – Uses.

Kern method – Bell Delware method – classification of baffles – Demo about HTRI Suite Software.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Kuppan T, “Heat Exchanger Design handbook”, 2nd Edition, CRC Press, 2013.
2. SadikKakac and Hongtan Liu, "Heat Exchangers Selection, Rating and Thermal Design”, CRC Press, 2012.

19ME02L	ENERGY AUDIT AND MANAGEMENT	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Recognise the role of energy manager in an industry (K4).

CO2: Apply the methodology to carry out energy audit and management of equipment and processes (K3).

Energy Scenario – Energy monitoring, auditing & targeting – Economics of various Energy Conservation schemes. Total Energy Systems.

Steam engineering – Conservation Measures in Steam; Boilers – types, losses and efficiency calculation as per Bureau of Energy Efficiency

Refrigeration and Air conditioning – Heat load estimation as per Bureau of Energy Efficiency – Energy conservation in cooling towers.

Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor – energy consumption and energy saving potentials.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Frank Kreith, Yogi Goswami D, “Energy Management and Conservation Handbook”, 2nd Edition, CRC Press, 2016.
2. Tarik Al-Shemmeri, “A Workbook for Energy Management in Buildings”, John Wiley & Sons, 2011.
3. Penni McLean-Conner, “Energy Efficiency: Principles and Practices”, Penn Well Books, 2009.
4. Barney L Capehart, Wayne C Turner, William J Kennedy, “Guide to Energy

Management", The Fairmont Press, Inc., 8th Edition2020.
5. Eastop T D, Croft D R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
6. Reay D A, "Industrial Energy Conservation", 1st Edition, Pergamon Press, 1979.
7. Bureau of Energy Efficiency Books, Volumes I-IV.

19ME03L	PYROLYSIS AND GASIFICATION	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: Design and development of pyrolysis and gasification process (K4).

Pyrolysis: Introduction – Types of pyrolysis – pyrolysis products – kinectics. Pyrolzer types – simple design.
Gasification: Gasifier Reactions and steps – gasification process – types of gasifiers: Fixed bed, fluidized bed and Simple process design.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Yongseung Yun, "Gasification for Practical Applications", InTech, 2012.
2. Prabir Basu, "Biomass Gasification and Pyrolysis Practical Design and Theory", Academic Press, Elsevier, 2010.
3. Jean – Pierre, "Biomass gasification: chemistry, Processes and applications", Nova Science Publishers, UK, 2009.
4. Christopher Higman, "Gasification", 2nd Edition, Gulf professional, Elsevier, 2008.
5. Berlin A A, "Chemical Physics of Pyrolysis, Combustion, and Oxidation", Nova Publishers, 2005.

19ME04L	GRID TIED PV SYSTEM DESIGN	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: Design and analyse on-grid photovoltaic systems. (K4)

Solar cells to solar array - On-Grid PV system - With and Without storage – Balance of system - DC-DC converters - Inverters - Net Metering - Design and analysis - Performance evaluation and monitoring - Field visit - Grid tied PV power plant.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Suneel Deambi, "Photovoltaic System Design: Procedures, Tools and Applications", CRC Press, 2016.

2. Chetan Singh Solanki, “Solar Photovoltaic Technology and Systems: a manual for technicians, trainers and Engineers”, Prentice Hall of India, 2014.
3. John R Balfour, Michael Shaw, “Advanced Photovoltaic System Design”, Jones & Bartlett Publishers, 2011.
4. Roger Messenger, Amir Abtahi, “Photovoltaic Systems Engineering”, 3rd Edition, CRC Press, 2010.
5. James P Dunlop, “Photovoltaic Systems”, American Technical Publishers, 2nd Edition, 2012.
6. Web sources: www.pveducation.org; www.pveducation.com;
7. nptel.ac.in/courses/108105058/17

19ME05L	MICRO GRID	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Understand the main motivations and challenges for the implementation of microgrids. (K2)

Definition of Microgrids - Components & Microgrid Layouts - Power Electronic Interfaces in Microgrids - Intelligent Local Controllers – Storage devices for Microgrids - Control in Microgrids - DC Microgrids- Protection – Faults

L:15; TOTAL:15 PERIODS

REFERENCES

1. Chetan Singh Solanki, “Solar Photovoltaics Fundamentals, Technologies and Applications”, Prentice Hall of India, 2nd Edition, 2015.
2. James P Dunlop, “Photovoltaic Systems”, American Technical Publishers, 2nd Edition, 2012.
3. Robert Foster, Majid Ghassemi and Alma Cota, “Solar Energy – Renewable Energy and the Environment”, CRC Press, 2009.

19ME06L	THERMAL ENERGY STORAGE SYSTEMS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Identify the optimal energy storage technology to any application (K3).

Thermal Storage Concepts - Materials for Sensible and Latent Heat Energy Storage - Materials for Low and High Temperature Storage Applications - charging and discharging characteristics - Design of storage system– performance - Thermo-chemical storage.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Palacios A, Barreneche C, Navarro ME, Ding Y, "Thermal energy storage technologies for concentrated solar power – A review from a materials perspective", Renewable Energy, 2019.
2. Nazir Hassan et al., "Recent developments in phase change materials for energy storage applications: A review". International Journal of Heat and Mass Transfer, vol. 129 (2019), pp. 491-523.
3. KocakBurcu, Fernandez Ana Ines, PaksoyHalime "Review on sensible thermal energy storage for industrial solar applications and sustainability aspects" Solar Energy, vol. 209 (2020), pp. 135-169.
4. Luisa F. Cabeza, Advances in Thermal Energy Storage Systems: Methods and Applications, Elsevier Woodhead Publishing, 2015
5. Ibrahim Dincer and Marc A Rosen, "Thermal Energy Storage: Systems and Applications", 2nd Edition, John Wiley & Sons, Ltd., 2010.
6. H.P. Garg, S.C. Mullick, Vijay K. Bhargava, "Solar Thermal Energy Storage" D Reidel Publishing Co., 2011

19ME07L	SOLAR COOLING SYSTEMS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Estimate the size of cooling system components based on hardware, climate, and economic constraints. (K4).

Introduction - Conversion of Solar Radiation into Cooling or Air-conditioning - Absorption Cooling - Rankine Cycle Heat Engine Cooling - Desiccant Cooling - Other Cooling Methods - Estimating System Size - System Controls - Piping, Pumps, Valves - Collectors - Other Considerations – Case studies.

L:15; TOTAL:15 PERIODS

REFERENCES

1. IoanSarbu Calin Sebarchievici, "Solar Heating and Cooling Systems, Fundamentals, Experiments and Applications", 1st Edition, Academic Press, 2016.
2. SotiriosKarellas, Tryfon C Roumpedakis, Nikolaos Tzouganatos, Konstantinos Braimakis." Solar Cooling Technologies", CRC Press; 1st Edition (18 October 2018).
3. Daniel Mugnier, Daniel Neyer, Stephen D. White, "The Solar Cooling Design Guide-Case Studies of Successful Solar Air Conditioning Design: Case Studies of Successful Solar Air Conditioning Design", John Wiley & Sons, Inc., 2017.
4. Paul Kohlenbach, Uli Jakob, "Solar Cooling the Earthscan Expert Guide to Solar Cooling Systems", 1st Edition, Taylor & Francis, 2014.
5. R.Z. Wang and T.S. Ge," Advances in Solar Heating and Cooling", Elsevier Ltd., 2016.
6. John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", Third Edition, John Wiley & Sons, 2006.

19ME08L	DESALINATION	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Choose suitable desalination technology for given application (K3).

Desalination technologies – Membrane, Thermal and hybrid Desalination – Forward osmosis - Construction and design of Simple solar still – Solar PV powered Desalination - Solar disinfection and its methods - Solar thermal Desalination: passive and active type - Materials for Insulation, Heat storage – Technical Challenges – Performance - Case studies

L:15; TOTAL:15 PERIODS

REFERENCES

1. Ahmad et al., “Current advances in membrane technologies for produced water desalination”, Desalination, Vol-493, pp-114643, 2020.
2. Shaheen Fatima Anisa, RaedHashaikeha, Nidal Hilal, “Functional materials in desalination: A review”, Desalination, Vol-468, pp-114077, 2019.
3. Farah Ejaz Ahmed, RaedHashaikeh, Nidal Hilal, “Hybrid technologies: The future of energy efficient desalination – A review”, Desalination, Vol-495, pp-114659, 2020.
4. B.Anand et al., “A review on solar photovoltaic thermal integrated desalination technologies”, Renewable and Sustainable Energy Reviews, Vol-141, pp-110787, 2021.
5. Chauhan VK, Shukla SK, Tirkey JV, Singh Rathore PK, “A comprehensive review of direct solar desalination techniques and its advancements”, Journal of Cleaner Production, 2020.
6. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
7. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi, 2010.

19ME09L	THERMAL CHARACTERIZATION OF MATERIALS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Choose the method for thermal characterization of the materials. (K3)

Thermal characterization of materials such as: Organic - polymeric materials - composites - bio-materials - general theory of inorganic materials - metals. The micro and macroscopic thermal properties – Specific Heat, Thermal Diffusivity, Thermal Conductivity, coefficient of linear thermal expansion, moisture diffusivity, heat of vaporization and heat of combustion.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Askeland D.R. (1996) Thermal Properties of Materials. In: The Science and Engineering of Materials. Springer, Boston, MA. https://doi.org/10.1007/978-1-4899-2895-5_21
2. Jannot, Y., &Degiovanni, A, "Thermal properties measurement of materials", John Wiley & Sons, 2018.
3. Khachan, J, "Thermal properties of matter", Morgan & Claypool Publishers, 2018.

19ME10L	THERMAL ANALYSIS OF MECHANICAL SYSTEMS USING FEM	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply finite element solutions to Formulate and solve thermal problems on some simple mechanical systems. (K3)

Introduction to Scalar problems – One dimension and Two-dimension Finite element Heat Transfer: Basic equations of heat transfer and finite element formulation: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid - Case studies: heat transfer in composite sections, straight fins, Thermal analysis of an IC engine cylinder - Transient Thermal Analysis. Demonstration using FEM.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Seshu P, "Textbook of finite element analysis" PHI learning pvt ltd, New Delhi, 2012
2. David V Hutton "Fundamentals of finite element analysis" Tata McGraw Hill, 2005.
3. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
4. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
5. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.
6. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.
7. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

19ME11L	INDUSTRIAL DRAWING READING WITH GEOMETRIC DIMENSIONING AND TOLERANCING	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: inteapret limits, fits and tolerance in component drawing (K3)

Industrial Drawing reading – First and third angle projection – free hand sketches – BIS SP46 - Engineering drawing and tolerance – Limits, fits and Tolerance – Tolerance symbols and terms – rules and concepts of GD&T - use of GD&T – MMC, LMC – datum – Form – Orientation – profile – Runout.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Alex Krulikowsi, "Fundamentals of Geometric Dimensioning and Tolerancing", 2nd Edition, Delmar publications, 2012.
2. Standards for dimensioning and tolerancing - ASME Y 14.5, 2009.
3. James D Meadows, "GD&T Application, analysis and Measurements", ASME Press 2009.

19ME12L	**FUNDAMENTALS OF PROCESS EQUIPMENT**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: design the components of process equipment (K3).

Pressure Vessel Introduction – Design of Flanges – Design of supports for vertical and horizontal vessels – Openings, nozzles and External loadings – Storage Vessels - Evaporators crystallizers – Distillation and fractionization equipment.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Joshi, "Process Equipment Design", Macmillan Company of India, 2016.
2. Dennis R Moss, Michael M. "Pressure Vessel Design Manual", 4th Edition, Butterworth-Heinemann, 2012.
3. James R Couper, Roy Penney W, James R Fair, "Chemical Process Equipment: Selection and Design", 3rd Edition, Elsevier, 2012.
4. Stanley M Walas, "Chemical Process Equipment Selection and design", Butterworth-Heinemann, 1988.
5. Lloyd E Brownell and Edwin H Young, "Process Equipment Design: Vessel Design", John Wiley & Sons, 1959.

19ME13L	**TECHNIQUES FOR VIBRATION MONITORING AND CONTROLS**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply vibration-based condition monitoring in rotating machineries. (K3).

Condition monitoring- methods – measurement of vibration, Vibration analysis, Vibration and predictive maintenance, Monitoring machine vibration, Vibration transducers, Common vibration monitoring techniques, Error analysis - Industrial case studies. Active

and passive techniques in vibration control.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Davies A, “Handbook of Condition Monitoring: Techniques and Methodology”, Springer Science & Business Media, 2012.
2. Anders Brandt, “Noise and Vibration Analysis: Signal Analysis and Experimental Procedures”, John Wiley & Sons, 2011.
3. Robert Bond Randall, “Vibration-based Condition Monitoring”, John Wiley and Sons, Ltd., 2011.
4. Peter Tavner, Li Ran, Jim Penman, “Condition Monitoring of Rotating Electrical Machines”, the Institution of Engineering and Technology, London, United Kingdom, 2008.
5. Lihui Wang, Robert X Gao, “Condition Monitoring and Control for Intelligent Manufacturing”, Springer Science & Business Media, 2006.
6. Rao B K N, Davies A, “Handbook of Condition Monitoring Techniques and Methodology”, Springer-science business media, 1998.
7. Rao B K N, “Handbook of Condition Monitoring”, Elsevier, 1996.

19ME14L	CRASHWORTHINESS OF TUBULAR SHELLS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Assess the crashworthiness characteristics of thin-walled tubes/plates (K3).

Structural members – types – Introduction to Plates and Shells – Difference between plates and shells - selection and applications. Crashworthiness – definitions - types of loading - Influence of materials, shape, and boundary conditions on energy absorption and mode of collapse.

Evaluation on crashworthiness characteristics of simple shell member. Case studies – impact on helmets – mode of collapse - inferences.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Ahmed Elmarakbi, Lukaszewicz, “Automotive Composite Structures for Crashworthiness”, John Wiley & Sons Ltd, 2014.
2. Ambrosio J A C, “Crashworthiness: Energy Management and Occupant Protection”, Springer, 2001.
3. http://www.tandfonline.com/toc/tcrs20/current.
4. https://www.journals.elsevier.com/thin-walled-structures/
5. https://www.journals.elsevier.com/international-journal-of-impact-engineering.
6. https://www.journals.elsevier.com/composite-structures.
7. https://www.journals.elsevier.com/materials-and-design/

19ME15L	FAILURE MODE AND EFFECTS ANALYSIS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply FMEA techniques for product improvement (K3).

Failure mode effect analysis (FMEA) – requirements of reliability - failure rate – FMEA stages – Types of FMEA - Failure - Failure mode - Failure cause and/or mechanism - Failure effect – Detection – Probability - Risk Priority Number (RPN) – Severity - Remarks / mitigation / actions.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Bilal M Ayyub, “Risk Analysis in Engineering and Economics”, 2nd Edition, CRC Press, 2014.
2. Carl Carlson, “Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes using Failure Mode and Effects Analysis”, John Wiley & Sons, 2012.
3. Raymond J Mikulak, Robin McDermott, Michael Beauregard, “The Basics of FMEA”, 2nd Edition, CRC Press, 2008.
4. Stamatis D H, “Failure Mode and Effect Analysis”, ASQ Quality Press, 2003.
5. Kevin Otto, Kristin Wood, “Product Design Techniques in Reverse Engineering and New Product Development”, Pearson Education (LPE), 2001.

19ME16L	DESIGN OF EXPERIMENTS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply suitable techniques for design of experiments in an engineering product design and evaluation (K3).

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments – Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi’s approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Linda C Schmidt, George E Dieter, “Engineering design”, McGraw-Hill Education, 2015.
2. Jiju Antony, “Design of Experiments for Engineers and Scientists”, Elsevier, 2014.
3. Paul G Mathews, “Design of Experiments with MINITAB”, ASQ Quality Press, 2005.
4. Ronald Fisher, “The Design of Experiments”, Hafner Press, 8th Revised edition, 1972.

19ME17L	TAGUCHI METHODS	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply Taguchi methods in design of experiments (K3).

Overview of Design of Experiments and Taguchi approach - common experiments and methods of analysis. Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design - control and noise factors, S/N ratios, parameter design, Multilevel experiments, Multi response optimization – case studies.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Krishnaiah K and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI learning private Ltd., 2012.
2. Khosrow Dehnad, “Quality Control, Robust Design and the Taguchi Method”, Springer, 2012.
3. Ranjit K Roy, “A Primer on the Taguchi Method”, 2nd Edition, Society of Manufacturing Engineers, 2010.
4. Ranjit K Roy, “Design of Experiments using the Taguchi Approach”, John Wiley & sons, Inc., 2001.
5. Nicolo Belavendram, “Quality by Design; Taguchi techniques for industrial experimentation”, Prentice Hall, 1995.

19ME18L	CREATIVE AND INNOVATIVE METHODS FOR DESIGN AND DEVELOPMENT	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Apply the innovative design process and rapid prototyping process in new part developments (K3).

Design thinking – Market Research – Identifying and involving the lead user - Creating Ideal Conditions – Decision making in design process –Understand-Observe-Point of view-ideate-prototype-test– Dealing with Project Goals- using task board- Gantt Chart for time and resource planning. **Value Analysis** – Need analysis, Function Analysis, Solution, Cost Analysis.

Rapid Prototyping processes – 3D printing – metal additive manufacturing – selective laser melting technique - applications and limitations.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Christian Muller-Robertberg, “Design Thinking for Dummies”, John Wiley & Sons, 2020.

2. Thomas Lockwood, "Design Thinking – Integrating Innovation, Customer Experience, Brand value", Allworth Press, 2009.
3. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development", Tata McGraw-Hill Education, 4th Edition, 2009.
4. Hasso Plattner, Christoph Meinel, Larry Leifer, "Design Thinking - Understand – Improve – Apply", 3rd Edition, Springer-Verlag Berlin Heidelberg, 2009.
5. Walter Brenner, Falk Uebernickel "Design thinking for Innovation", Springer, 2016.

19ME19L	CREEP AND FATIGUE	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Describe the concept of creep and fatigue (K2)

Creep and fracture at high temperature: High temperature deformation-importance, creep and stress rupture tests, creep curve, different stages of creep curve, Sherby-Dorn equation, mechanisms of creep deformation, super plasticity, prediction of longtime properties, fracture at elevated temperature, design of creep resistant alloys.

Fatigue: Stress cycles, fatigue test, S-N curve, cycle stress strain curve, low cycle and high cycle fatigue, effect of mean stress on fatigue, structural features of fatigue, Fatigue crack propagation, factors affecting fatigue: surface condition and metallurgical variables.

L:15; TOTAL:15 PERIODS

REFERENCES

1. George E. Dieter, "Mechanical Metallurgy", 3rd Edition, McGraw-Hill, 1988.
2. Thomas H. Courtney, "Mechanical Behavior of Materials", MeGraw-Hill, 2000.
3. Marc Andre Meyers and Krishan Kumar Chawla, "Mechanical Metallurgy, Principles and Applications", 1984.

19ME20L	NATURAL FIBER COMPOSITES	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: describe the characteristics of different natural fibers and its composites (K2).

Fundamentals of natural fiber composite materials: Natural fibers - bio diversity-extraction methods-polymer matrix - composite fabrication methods. Pre-processing methods of natural fibers: Introduction - Chemical agents used for natural fiber surface modification-treatment procedures. Characterization of natural fibers: FTIR spectrography, SEM topography and other testing methods- investigations. Applications in Automotive Industry.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Campilho R D S G, “Natural Fiber Composites”, CRC Press, 2015.
2. Alma Hodzic, Robert Shanks, “Natural Fibre Composites: Materials, Processes and Properties”, Woodhead Publishing, 2014.
3. Douglas D Stokke, Qinglin Wu, Guangping Han, “Introduction to Wood and Natural Fiber Composites”, John Wiley & Sons, 2013.
4. Ning Hu, “Composites and their properties”, Intech, 2012.
5. Adel zakiel-sonbati, “Thermoplastic-composite materials”, InTech, 2012.
6. John cuppoleeti, “Metal, ceramic and polymeric composites for various uses”, Intech, 2011.
7. Frederick T Wallenberger, Norman Weston, “Natural Fibers, Plastics and Composites”, Springer Science & Business Media, 2011.
8. BrahimAttaf, “Advances in composite materials-eco design and analysis”, Intech, 2011.
9. Pickering K, “Properties and Performance of Natural-Fibre Composites”, Elsevier, 2008.

19ME21L	FUNCTIONAL MATERIALS FOR ENERGY CONVERSION	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: Select functional materials for energy conversion and storage. (K4)

Procedure for functional material development. Review of materials developed/available. Need for functional materials, synthesis methods, energy application. Design philosophy of functional materials, Nanostructures and Advanced Materials for solar energy conversion, fuel cell and energy storage.

L:15; TOTAL:15 PERIODS

REFERENCES

1. David Munoz-Rojas, Xavier Moya, “Materials for Sustainable Energy Applications: Conversion, Storage, Transmission, and Consumption”, Pan Stanford Publishing, 2016.
2. Kilner J A, Skinner S J, Irvine S J C, Edwards P P, “Functional Materials for Sustainable Energy Applications”, Woodhead Publishing Limited, 2012.

19ME22L	DESIGN FOR MANUFACTURABILITY	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: Apply the concepts of design for manufacturability. (K3).

Review of Tolerances, Limits and Fits. Influences of materials Space factor, Size and Weight on form design. Design for machining, casting, forging and welding.

L:15; TOTAL:15 PERIODS

REFERENCES

1. David M Anderson, "Design for Manufacturability: How to Use Concurrent Engineering to Rapidly Develop Low-Cost, High-Quality Products for Lean Production", CRC Press, 2014.
2. Chitale A K, Gupta R C, "Product Design and Manufacturing", PHI Learning Pvt. Ltd., 2013.
3. David M Anderson, "Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality", Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
4. Boothroyd G, Dewhurst P and Knight W, "Product Design for Manufacture and Assembly", Marcell Dekker, 2002.
5. Harry Peck, "Designing for Manufacture", Pitman Publishing, 1983.
6. Chitale A K and Gupta R C, "Product Design and Manufacturing", PHI 2007
7. Bralla J G, "Hand Book of Product Design for Manufacturing", McGraw Hill Publications, 2000.

19ME23L	**SIX SIGMA**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the history and basics of six sigma (K2)

CO2: form a Team, using the DMAIC process to solve a problem (K3)

History and development of Six Sigma – Definition – Common principles – Fundamentals - Roles & Responsibilities – Deliverables - challenges of six sigma - Defining a Six Sigma Project –Benefits and Application.

Lean concept – Seven muda – 5S – JIT – Basic 6σ Concept – Standard Deviation - Pareto principle – voice of customer – 5why's – SIPOC Process - Building a 6σ team – DMAIC and DMADV – Case study.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Dale H Besterfiled, "Total Quality Management", Pearson Education Asia, 3rd Edition, Indian Reprint 2012.
2. Janakiraman B and Gopal R K, "Total Quality Management -Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006
3. James R Evans and William M Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2019.
4. Oakland J S, "TQM -Text with Cases", Butterworth-Heinemann Ltd., Oxford, 3rd Edition, 2003.
5. Suganthi L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

19ME24L	AGILE MANUFACTURING	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: describe the concept of agile manufacturing (K2)

Fundamentals of Agile Manufacturing, The Agile Production Paradigm, Agile Principles, Conceptual models of Agile Manufacturing, Agile Practices - Agile practice for product development - Manufacturing agile practices - Developing the agile enterprise - understanding the value of investing in people, Managing People in agile organizations - Infusing managerial principles for enabling agility. Information Technology applications in Agile Manufacturing.

L:15; TOTAL:15 PERIODS

REFERENCE

1. Devadasan, S.R., Sivakumar, V., Mohan Murugesh, R., Shalij, P, R. “Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities”, Prentice Hall India, 2012.

19ME25L	SURFACE ENGINEERING	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to
CO1: explain the various theories and practice on surface engineering and surface modification methods to solve the industrial practical problems. (K2)

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings. Characterization of coatings and surfaces: Measurement of coatings thickness, porosity & adhesion of surface coatings, Measurement of residual stress & stability, Surface microscopy, topography and Spectroscopic analysis of modified surfaces – Surface Texturing.

L:15; TOTAL:15 PERIODS

REFERENCES

1. G.W.Stachowiak & A.W. Batchelor , “Engineering Tribology”, Butterworth-Heinemann, UK, 2016.
2. Halling, J. (Editor), “Principles of Tribology“, Macmillian – 1984.
3. Rabinowicz.E, “Friction and Wear of materials”, John Willey & Sons, UK, 1995.
4. S.K.Basu, S.N.Sengupta & B.B. Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India Pvt Ltd , New Delhi, 2005.

19ME26L	OPTIMIZATION IN SCHEDULING	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: Choose various objectives, constraints and parameters of scheduling environment (K3).

CO2: Apply evolutionary algorithms to scheduling problems with single and multi-objectives (K3).

Scheduling fundamentals

Single machine scheduling - Measures of performance - Shortest processing time (SPT) - Rule to minimize Mean flow time - Weighted mean flow time - Earliest Due Date - Rule to minimize maximum lateness - Model to minimize total tardiness. Branch and Bound technique – Hodgson's algorithm- Parallel processor in single machine scheduling. Application of scheduling Software.

Optimization in Scheduling

Flow shop and Job shop scheduling- Evolutionary algorithms – Johnson's algorithm. GA – application to scheduling problems - structure – Binary coded and real coded – parameters- crossover, mutation, local optimal, global optimal. Single and multi-objective optimization.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Alessandro Agnetis, Jean-Charles Billaut, StanisławGawiejnowicz, Dario Pacciarelli, AmeurSoukhal, "Multiagent Scheduling: Models and Algorithms", Springer Science & Business Media, 2014.
2. Panneerselvam R, "Production and Operations Management", PHI Learning Pvt. Ltd., 2012.
3. Jacek Błażewicz, Klaus H Ecker, Erwin Pesch, Günter Schmidt, Jan Weglarz, "Handbook on Scheduling: From Theory to Applications", Springer Science & Business Media, 2007.
4. Rajendran Saravanan, "Manufacturing Optimization through Intelligent Techniques", CRC Press, 2017.
5. Joseph Y-T Leung, "Handbook of Scheduling: Algorithms, Models, and Performance Analysis", CRC Press, 2004.

19ME27L	DESIGN A STARTUP	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: design a startup

Module 1: What is Design Thinking and Its importance for startup Creation

Innovation and Design thinking. Managing the New Product Development using Design Thinking. A Detail Analysis of Entrepreneurs vs Innovators.

Module 2: Discovery of Real-World Problems

Problem Identification Tackle Wicked Problems. Obstacles to Problem Solving. Empathy in Design Thinking. The role of empathy in the design thinking process and the tools we can use. Empathizes with Your Users. How do we learn what people want? How to employ ethnographic and analysis methods, such as interviews, focus groups, and surveys.

Module 3: Defining Problem Statement. Cause and Effect of a Problem

Module 4: What is creative thinking, critical thinking and other types of thinking

Design Thinking as a Problem-Solving tool Learn to solve problems like a designer.

Module 5: Fuzzy Front end of Innovation and Ideation

What is Ideation and Essential Ideation Techniques. Managing Fuzzy Front end of Innovation. Impact and purpose of this ideas Present the ideas in this course together with the team and show how Startups or Intrapreneurs can create impact from ideas. Measuring impact and the value created through creativity.

Module 6: Idea to Concept to PoC

Module 7: Get Started with Prototyping. Start with Low-Fi Prototype and move on to develop a MVP

Why prototyping is so important in Design Thinking. How to prototype early and fast, as well as test your prototypes so as to reduce risks and accelerate organizational learning.What is lean Startup Methodology and how to develop MVP.

Module 8: Embracing Failure

Experiment to Innovate. Inculcate a culture that embraces failure. Teach students how to "Fail fast, fail cheap, fail often and Learn Fast.

Module 9: Group Presentation

L:15; TOTAL:15 PERIODS

REFERENCES

1. Roger L Martin, "The Design of Business", Harvard Business Review Press; 3rd Edition, 2009
2. Tim Brown, "Change by Design", Harper Business, 2019.

19ME28L	PREDICTIVE MAINTENANCE	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply predictive modelling and classification modelling techniques for predictive maintenance (K3)

Regression model - prediction of remaining useful lifetime (RUL) - classification models - Prediction of machine and machine tool failure - Case Studies

L:15; TOTAL:15 PERIODS

REFERENCES

1. John D. Kelleher, Brian Mac Namee and Aoife D'Arcy, "Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms", MIT Press, 2015.
2. Vlad Sozonov, "The Fundamentals of Data Science", Vinco Publishing, 2019.
3. Andrew Park, "Python Machine Learning", 2020.

19ME29L	INTELLIGENT MANUFACTURING	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply intelligent manufacturing techniques to improve the product development and manufacturing process (K3).

Product development: Generative Design - Digital Twins - Optimizing production system performance and process: Increasing productivity and reliability – Quality analysis: Smart sensors for IoT applications -Computer vision-based quality control - Case Studies.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Fei Tao, Meng Zhang and A.Y.C. Nee, "Digital Twin Driven Smart Manufacturing", Elsevier, 2019.
2. Pal, S.K., Mishra, D., Pal, A., Dutta, S., Chakravarty, D., Pal, S, "Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing", Springer, 2011.
3. HirotoYasuura, Chong-Min Kyung, Yongpan Liu, Youn-Long Lin, "Smart Sensors at the IoT Frontier", Springer, 2017.
4. Sheila Anand, L. Priya, "A Guide for Machine Vision in Quality Control", CRC press, 2020.

19ME30L	ARTIFICIAL INTELLIGENCE IN PRODUCTION MANAGEMENT	L	T	P	C
		1	0	0	1

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: apply artificial intelligence technique to improve the productionmanagement activities. (K3)

Artificial Intelligence: Inventory management, Supply chain management, risk management, predictions on sales volume, Price and Demand forecasts - Case studies.

L:15; TOTAL:15 PERIODS

REFERENCES

1. Mary Kathryn Allen, “The Development of an Artificial Intelligence System for Inventory Management”, Council of Logistics Management, 1986.
2. Wolfgang Kersten, “Artificial Intelligence and Digital Transformation in Supply Chain Management”: Innovative Approaches for Supply Chains, 2019.
3. Hanne, Thomas, Dornberger, Rolf, “Computational Intelligence in Logistics and Supply Chain Management”, springer, 2017.
4. Saqib AzizMichael Dowling, “Machine Learning and AI for Risk Management”, Disrupting Finance, pp 33-50.
5. Archie Addo, Srini Centhala, Muthu Shanmugam, “Artificial Intelligence for Risk Management”, 2020.