VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

Thindal, Erode - 638 012

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
(Accredited by NAAC with 'A+' grade)

REGULATIONS 2018 Ver-4

CURRICULUM AND SYLLABUS

BE - MECHANICAL ENGINEERING

Choice Based Credit System (CBCS)

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY **(Autonomous)**
Department	Mechanical Engineering
Programme	BE- Mechanical Engineering
Regulations	2018 Ver-4

SUMMARY OF CREDITS

S.No	Course Category	Credits per Semester								Total Credits	Credits in %	Credits as per AICTE Model Curriculum
		1	2	3	4	5	6	7	8			
1	HS	3	3	0	0	0	0	3	0	9	5.5	12
2	BS	11	8	4	3	0	0	0	0	26	15.8	25
3	ES	8	9	7	4	0	0	0	0	28	16.9	24
4	PC	0	0	9	16	12	17	7	0	61	36.9	48
5	PE	0	0	0	0	6	6	6	0	18	10.9	18
6	OE	0	0	0	0	3	3	3	0	9	5.5	18
7	PSI	0	0	0	0	0	0	2	12	14	8.5	15
8	MC	✓	✓	✓	✓	✓	✓	✓	✓	0	0	-
9	VC	✓										-
10	OC, SC, AC	✓										-
Total Credits / Sem		22	20	20	23	21	26	21	12	165		160

HS - Humanities and Social Science
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
PSI - Project, Seminar, Internship, etc.
MC - Mandatory Course
VC - Value added course (If three or more credits earned, then one elective course may be exempted)
OC - Online Course (If six or more credits earned, then two elective courses may be exempted)
SC - Self Study course
AC - Audit Course

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM UG R 2018 Ver -4

Department	Mechanical Engineering (ME)
Programme	B.E - ME

INCORPORATING RELATIVE GRADING SYSTEM

Semester 1

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	HS	21ENT11	Communicative English - I	3	0	0	3	40	60	100
2	BS	21MAT11	Engineering Mathematics - I	3	1	0	4	40	60	100
3	BS	21PHT11	Engineering Physics	3	0	0	3	40	60	100
4	BS	21CYT11	Engineering Chemistry	3	0	0	3	40	60	100
5	ES	21EET11	Basics of Electrical and Electronics Engineering	3	0	0	3	40	60	100
6	ES	21MEC11	Engineering Graphics	2	0	4	4	40	60	100
PRACTICALS										
7	BS	21PHL11	Physics and Chemistry Laboratory - I	0	0	3	1	60	40	100
8	ES	21MEL11	Workshop Practices Laboratory	0	0	3	1	100	0	100
MANDATORY COURSES										
9	MC	21MCL11	Universal Human Values-I	1	0	1	0	100	0	100
			Total credits for Sem	1			22			

Semester 2

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	HS	21ENT21	Communicative English - II	3	0	0	3	40	60	100
2	BS	21MAT21	Engineering Mathematics - II	3	1	0	4	40	60	100
3	BS	21PHT21	Materials Science	3	0	0	3	40	60	100
4	ES	21CST11	Problem Solving and Python Programming	3	0	0	3	40	60	100
5	ES	21MET21	Engineering Mechanics	3	1	0	4	40	60	100
PRACTICALS										
6	BS	21PHL21	Physics and Chemistry Laboratory - II	0	0	3	1	60	40	100
7	ES	21CSL11	Problem Solving and Python Programming Lab	0	0	3	1	60	40	100
8	ES	21MEL22	Computer Aided Drafting and Modeling	0	0	3	1	60	40	100
MANDATORY COURSES										
9	MC	21MCT02	Environmental Science and Engineering	2	0	0	0	10	0	100
			Total credits for Sem	2			20			

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Department	Mechanical Engineering (ME)
Programme	B.E - ME
Semester	3

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	BS	21MAT31	Transforms and Partial Differential Equations	3	1	0	4	40	60	100
2	ES	21MET31	Fluid Mechanics and Machinery	3	0	0	3	40	60	100
3	ES	21EEC31	Electrical Drives and Control	3	0	2	4	50	50	100
4	PC	21MET32	Engineering Thermodynamics	3	1	0	4	40	60	100
5	PC	21MET33	Manufacturing Technology	3	0	0	3	40	60	100
PRACTICALS										
6	PC	21MEL31	Manufacturing Technology Laboratory	0	0	3	1	60	40	100
7	PC	21MEL32	Fluid Mechanics and Machinery Laboratory	0	0	3	1	60	40	100
MANDATORY COURSES										
8	MC	21MCL03	Essential English for Professionals	0	0	2	0	100	0	100
			Total credits for Sem	3			20			

Semester	4

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	BS	21MAT44	Statistics and Numerical Methods	3	0	0	3	40	60	100
2	PC	21MET41	Design Engineering	3	0	0	3	40	60	100
3	ES	21MEC42	Strength of Materials	3	0	2	4	50	50	100
4	PC	21MET43	Thermal Engineering	3	1	0	4	40	60	100
5	PC	21MET44	Theory of Machines	3	1	0	4	40	60	100
6	PC	21MET45	Engineering Materials and Metallurgy	3	0	0	3	40	60	100
PRACTICALS										
7	PC	21MEL41	Machining Processes Laboratory	0	0	3	1	60	40	100
8	PC	21MEL42	Thermal Engineering Laboratory	0	0	3	1	60	40	100
MANDATORY COURSES										
9	MC	21MCL04	Professional Communication	0	0	2	0	100	0	100
			Total credits for Sem	4			23			

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Department	Mechanical Engineering (ME)
Programme	B.E - ME

Semester 5

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	21MET51	Machine Design	3	1	0	4	40	60	100
2	PC	21MET52	Automobile Engineering	3	0	0	3	40	60	100
3	PC	21MET53	Metrology and Measurements	3	0	0	3	40	60	100
4	PE		Professional Elective – 1	3	0	0	3	40	60	100
5	PE		Professional Elective – 2	3	0	0	3	40	60	100
6	OE		Open Elective – 1	3	0	0	3	40	60	100
PRACTICALS										
7	PC	21MEL51	Computer Aided Design Laboratory	0	0	2	1	60	40	100
8	PC	21MEL52	Dynamics and Metrology Laboratory	0	0	2	1	60	40	100
MANDATORY COURSES										
9	MC	21MCT05	Aptitude and Logical Reasoning	2	0	0	0	100	0	100
10	MC	21MCL09	Communication Skills Laboratory	0	0	2	0	100	0	100
			Total credits for Sem	5			21			

Semester 6

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	21MET61	Design of Transmission Systems	3	1	0	4	40	60	100
2	PC	21MET62	Heat and Mass Transfer	3	1	0	4	40	60	100
3	PC	21MET63	Finite Element Analysis	3	1	0	4	40	60	100
4	PE		Professional Elective -3	3	0	0	3	40	60	100
5	PE		Professional Elective -4	3	0	0	3	40	60	100
6	OE		Open Elective - 2	3	0	0	3	40	60	100
PRACTICALS										
7	PSI	21MEL61	Design and Fabrication Project	0	0	6	3	40	60	100
8	PC	21MEL62	Simulation and Analysis Laboratory	0	0	2	1	60	40	100
9	PC	21MEL63	Heat and Mass Transfer Laboratory	0	0	2	1	60	40	100
MANDATORY COURSES										
10	MC	21MCT07	Arithmetic and Analytical Ability	2	0	0	0	100	0	100
			Total credits for Sem	6			26			

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM UG R 2018 Ver-4

Department	Mechanical Engineering (ME)
Programme	B.E - ME
Semester	7

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	PC	21MET71	Total Quality Management	3	0	0	3	40	60	100
2	PC	21MEC72	Mechatronics	3	0	2	4	50	50	100
3	PE		Professional Elective -5	3	0	0	3	40	60	100
4	PE		Professional Elective -6	3	0	0	3	40	60	100
5	OE		Open Elective – 3	3	0	0	3	40	60	100
6	HS	21HST71	Human Values and Professional Ethics	3	0	0	3	40	6	100
PRACTICALS										
8	PSI	21MEL71	Automation Laboratory	0	0	2	1	60	40	100
9	PSI	21MEL72	Comprehension	0	0	2	1	100	0	100
MANDATORY COURSES										
10	MC	21MCT08	Indian Constitution and Traditional Knowledge	2	0	0	0	100	0	100
			Total credits for Sem	7			21			

Semester	8

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
PRACTICALS										
1	PSI	21MEL81	Internship	-	-	-	2	100	0	100
2	PSI	21MEL82	Project Work	0	0	20	10	40	60	100
			Total credits for Sem	8			12			

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6
DESIGN ENGINEERING	MANUFACTURING ENGINEERING	INDUSTRIAL ENGINEEREING	INDUSTRIAL MANAGEMENT	THERMAL ENGINEERING	INTER/MULTI-DISCIPLINARY COURSES
CAD / CAM / CIM	Additive Manufacturing	Lean Manufacturing and Six Sigma	Maintenance Engineering	Gas Dynamics and Jet Propulsion	Enterprise Resource Planning (ERP)
Composite Materials	Non-Destructive Testing	Plant Layout and Material Handling	Product Lifecycle Management	Power Plant Engineering	Design for Manufacture and Assembly
Design and Analysis of Experiments	Unconventional Machining Processes	Process Planning and Cost Estimation	Principles of Management	Advanced I.C. Engines	Robotics
Mechanical Vibrations	Digital Manufacturing and IoT	Supply Chain Management	Engineering Economics and Project Management	Refrigeration and Airconditioning	Nanotechnology
Design of Jigs, Fixtures and Press Tools	Industry 4.0	Industrial Safety Engineering	New Product Development	Fluid Power Systems	Bio-Mechanics
Industrial Tribology	Flexible Manufacturing Systems	Operations Research	Ergonomics in Design	Computational Fluid Dynamics	Micro Electro-Mechanical Systems
Machine Drawing	Advanced Casting and Welding Processes	Quality Control and Reliability Engineering	Production Planning and Control	Cryogenic Engineering	Surface Engineering

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.
The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree.

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
VERTICAL 1: DESIGN ENGINEERING										
1	PE	21MEE11	CAD / CAM /CIM	3	0	0	3	40	60	100
2	PE	21MEE12	Composite Materials	3	0	0	3	40	60	100
3	PE	21MEE13	Design and Analysis of Experiments	3	0	0	3	40	60	100
4	PE	21MEE14	Mechanical Vibrations	3	0	0	3	40	60	100
5	PE	21MEE15	Design of Jigs, Fixtures and Press Tools	3	0	0	3	40	60	100
6	PE	21MEE16	Industrial Tribology	3	0	0	3	40	60	100
7	PE	21MEE17	Machine Drawing	3	0	0	3	40	60	100
VERTICAL 2: MANUFACTURING ENGINEERING										
8	PE	21MEE21	Additive Manufacturing	3	0	0	3	40	60	100
9	PE	21MEE22	Non Destructive Testing	3	0	0	3	40	60	100
10	PE	21MEE23	Unconventional Machining Processes	3	0	0	3	40	60	100
11	PE	21MEE24	Digital Manufacturing and IoT	3	0	0	3	40	60	100
12	PE	21MEE25	Industry 4.0	3	0	0	3	40	60	100
13	PE	21MEE26	Flexible Manufacturing Systems	3	0	0	3	40	60	100
14	PE	21MEE27	Advanced Casting and Welding Processes	3	0	0	3	40	60	100
VERTICAL 3: INDUSTRIAL ENGINEERING										
15	PE	21MEE31	Lean Manufacturing and Six Sigma	3	0	0	3	40	60	100
16	PE	21MEE32	Plant Layout and Material Handling	3	0	0	3	40	60	100
17	PE	21MEE33	Process Planning and Cost Estimation	3	0	0	3	40	60	100
18	PE	21MEE34	Supply Chain Management	3	0	0	3	40	60	100
19	PE	21MEE35	Industrial Safety Engineering	3	0	0	3	40	60	100
20	PE	21MEE36	Operations Research	3	0	0	3	40	60	100
21	PE	21MEE37	Quality Control and Reliability Engineering	3	0	0	3	40	60	100
VERTICAL 4: INDUSTRIAL MANAGEMENT										
22	PE	21MEE41	Maintenance Engineering	3	0	0	3	40	60	100
23	PE	21MEE42	Product Lifecycle Management	3	0	0	3	40	60	100
24	PE	21MEE43	Principles of Management	3	0	0	3	40	60	100
25	PE	21MEE44	Engineering Economics and Project Management	3	0	0	3	40	60	100
26	PE	21MEE45	New Product Development	3	0	0	3	40	60	100
27	PE	21MEE46	Ergonomics in Design	3	0	0	3	40	60	100
28	PE	21MEE47	Production Planning and Control	3	0	0	3	40	60	100

VERTICAL 5: THERMAL ENGINEERING										
29	PE	21MEE51	Gas Dynamics and Jet Propulsion	3	0	0	3	40	60	100
30	PE	21MEE52	Power Plant Engineering	3	0	0	3	40	60	100
31	PE	21MEE53	Advanced I.C. Engines	3	0	0	3	40	60	100
32	PE	21MEE54	Refrigeration and Airconditioning	3	0	0	3	40	60	100
33	PE	21MEE55	Fluid Power Systems	3	0	0	3	40	60	100
34	PE	21MEE56	Computational Fluid Dynamics	3	0	0	3	40	60	100
35	PE	21MEE57	Cryogenic Engineering	3	0	0	3	40	60	100
VERTICAL 6: INTER/MULTI-DISCIPLINARY COURSES										
36	PE	21MEE61	Enterprise Resource Planning (ERP)	3	0	0	3	40	60	100
37	PE	21MEE62	Design for Manufacture and Assembly	3	0	0	3	40	60	100
38	PE	21MEE63	Robotics	3	0	0	3	40	60	100
39	PE	21MEE64	Nanotechnology	3	0	0	3	40	60	100
40	PE	21MEE65	Biomechanics	3	0	0	3	40	60	100
41	PE	21MEE66	Micro Electro-Mechanical Systems	3	0	0	3	40	60	100
42	PE	21MEE67	Surface Engineering	3	0	0	3	40	60	100

Sl.No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING										
1	OE	21BMO01	Biotelemetry	3	0	0	3	40	60	100
2	OE	21BMO02	Biometric systems and their applications	3	0	0	3	40	60	100
3	OE	21BMO03	Biology for Engineers	3	0	0	3	40	60	100
4	OE	21BMO04	Healthcare Management Systems	3	0	0	3	40	60	100
5	OE	21BMO05	Medical Robotics	3	0	0	3	40	60	100
6	OE	21BMO06	Rapid Prototyping	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF CIVIL ENGINEERING										
1	OE	21CEO01	Civil and Infrastructure Engineering	3	0	0	3	40	60	100
2	OE	21CEO02	Environmental Pollution and waste management	3	0	0	3	40	60	100
3	OE	21CEO03	Disaster Management and Mitigation	3	0	0	3	40	60	100
4	OE	21CEO04	Building Services	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
1	OE	21CSO01	Cyber Security	3	0	0	3	40	60	100
2	OE	21CSO02	Web Designing	3	0	0	3	40	60	100
3	OE	21CSO03	Knowledge Management	3	0	0	3	40	60	100
4	OE	21CSO04	Green Computing	3	0	0	3	40	60	100
5*	OE	21CSO05	Principles of Artificial Intelligence	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
1	OE	21ECO01	Automotive Electronics	3	0	0	3	40	60	100
2	OE	21ECO02	SCILAB for Engineers	3	0	0	3	40	60	100
3	OE	21ECO03	Satellite Applications	3	0	0	3	40	60	100
4	OE	21ECO04	Consumer Electronics	3	0	0	3	40	60	100
5	OE	21ECO05	Principles of Communication Engineering	3	0	0	3	40	60	100
6	OE	21ECO06	Microcontroller based System Design	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
1	OE	21EEO01	PLC and SCADA	3	0	0	3	40	60	100
2	OE	21EEO02	Renewable Energy Sources	3	0	0	3	40	60	100
3	OE	21EEO03	Embedded Real Time System	3	0	0	3	40	60	100
4	OE	21EEO04	Energy Auditing and Conservation	3	0	0	3	40	60	100
5	OE	21EEO05	Electric Vehicles	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING										
1	OE	21MEO01	Industrial Instrumentation	3	0	0	3	40	60	100
2	OE	21MEO02	Product Design and Development	3	0	0	3	40	60	100
3	OE	21MEO03	Sustainable Manufacturing	3	0	0	3	40	60	100
4	OE	21MEO04	Entrepreneurship Development	3	0	0	3	40	60	100
5	OE	21MEO05	Fundamentals of Ergonomics	3	0	0	3	40	60	100
6	OE	21MEO06	Principles of Management and Industrial Psychology	3	0	0	3	40	60	100
7	OE	21MEO07	Safety Measures for Engineers	3	0	0	3	40	60	100

OFFERED BY DEPARTMENT OF MEDICAL ELECTRONICS										
1	OE	21MDO01	Introduction to Medical Electronics	3	0	0	3	40	60	100
2	OE	21MDO02	Hospital Waste Management	3	0	0	3	40	60	100
3	OE	21MDO03	Hospital Information System	3	0	0	3	40	60	100
4	OE	21MDO04	IoT Applications in Healthcare	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF INFORMATION TECHNOLOGY										
1	OE	21ITO01	Basics of Java Programming	3	0	0	3	40	60	100
2	OE	21ITO02	Ethical Hacking	3	0	0	3	40	60	100
3	OE	21ITO03	E-Commerce and Applications	3	0	0	3	40	60	100
4	OE	21ITO04	Basics of Android Application Development	3	0	0	3	40	60	100
5	OE	21ITO05	Principles of Data Science	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF SCIENCE AND HUMANITIES										
1	OE	21GEO01	National Cadet Corps Studies – I	3	0	0	3	40	60	100
2	OE	21GEO02	National Cadet Corps Studies – II	3	0	0	3	40	60	100

Sl.No	Category	**Course Code**	**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
VALUE ADDED COURSES										
1	OE	21MEV01	Finite Element Simulation using commercial analysis packages	1	0	2	1	100	0	100
2	OE	21MEV02	Geometric Dimensioning and Tolerancing	1	0	2	1	100	0	100
3	OE	21MEV03	CAM using commercial software packages	1	0	2	1	100	0	100
4	OE	21MEV04	Advanced modules for Design Engineers using CAD Packages	1	0	2	1	100	0	100
5	OE	21MEV05	Piping Design and Engineering	1	0	2	1	100	0	100
6	OE	21MEV06	Fixture design	1	0	2	1	100	0	100
7	OE	21MEV07	Machine Learning for Mechanical Engineers	1	0	2	1	100	0	100

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

VERTICALS FOR MINOR DEGREE

Vertical I	Vertical II	Vertical III	Vertical IV	Vertical V	Vertical VI
Fintech and Block chain	**Entrepreneurship**	**Public Administration**	**Business Data Analytics**	**Environment and Sustainability**	**Artificial Intelligence**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development	Introduction to Data Science
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management	Principles of Artificial Intelligence
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials	Data Warehousing and Data Mining
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Digital Marketing and Social Network Analytics	Materials for Energy Sustainability	Machine Learning Techniques
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Supply Chain Analytics	Green Technology	Expert Systems
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis	Cognitive Science
-	-	-	-	Integrated Energy Planning for Sustainable Development	Gamification
-	-	-	-	Energy Efficiency for Sustainable Development	-

Sl. No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
VERTICAL 1: FINTECH AND BLOCK CHAIN										
1	PE	21ITM11	Financial Management	3	0	0	3	40	60	100
2	PE	21ITM12	Fundamentals of Investment	3	0	0	3	40	60	100
3	PE	21ITM13	Banking, Financial Services and Insurance	3	0	0	3	40	60	100
4	PE	21ITM14	Introduction to Blockchain and its Applications	3	0	0	3	40	60	100
5	PE	21ITM15	Fintech Personal Finance and Payments	3	0	0	3	40	60	100
6	PE	21ITM16	Introduction to Fintech	3	0	0	3	40	60	100
VERTICAL 2: ENTREPRENEURSHIP										
7	PE	21MEM21	Foundations of Entrepreneurship	3	0	0	3	40	60	100
8	PE	21MEM22	Team Building and Leadership Management for Business	3	0	0	3	40	60	100
9	PE	21MEM23	Creativity and Innovation in Entrepreneurship	3	0	0	3	40	60	100
10	PE	21MEM24	Principles of Marketing Management for Business	3	0	0	3	40	60	100
11	PE	21MEM25	Human Resource Management for	3	0	0	3	40	60	100
12	PE	21MEM26	Financing New Business Ventures	3	0	0	3	40	60	100
VERTICAL 3: PUBLIC ADMINISTRATION										
13	PE	21ECM31	Principles of Public Administration	3	0	0	3	40	60	100
14	PE	21ECM32	Constitution of India	3	0	0	3	40	60	100
15	PE	21ECM33	Public Personnel Administration	3	0	0	3	40	60	100
16	PE	21ECM34	Administrative Theories	3	0	0	3	40	60	100
17	PE	21ECM35	Indian Administrative System	3	0	0	3	40	60	100
18	PE	21ECM36	Public Policy Administration							
VERTICAL 4: BUSINESS DATA ANALYTICS										
19	PE	21CSM41	Statistics for Management	3	0	0	3	40	60	100
20	PE	21CSM42	Datamining for Business Intelligence	3	0	0	3	40	60	100
21	PE	21CSM43	Human Resource Analytics	3	0	0	3	40	60	100
22	PE	21CSM44	Digital Marketing and Social Network Analytics	3	0	0	3	40	60	100
23	PE	21CSM45	Supply Chain Analytics	3	0	0	3	40	60	100
24	PE	21CSM46	Financial Analytics	3	0	0	3	40	60	100

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY										
25	PE	21CEM51	Sustainable infrastructure Development	3	0	0	3	40	60	100
26	PE	21CEM52	Sustainable Agriculture and Environmental Management	3	0	0	3	40	60	100
27	PE	21CEM53	Sustainable Bio Materials	3	0	0	3	40	60	100
28	PE	21CEM54	Materials for Energy Sustainability	3	0	0	3	40	60	100
29	PE	21CEM55	Green Technology	3	0	0	3	40	60	100
30	PE	21CEM56	Environmental Quality Monitoring and	3	0	0	3	40	60	100
31	PE	21CEM57	Integrated Energy Planning for Sustainable Development	3	0	0	3	40	60	100
32	PE	21CEM58	Energy Efficiency for Sustainable Development	3	0	0	3	40	60	100
VERTICAL 6: ARTIFICIAL INTELLIGENCE										
33	PE	21CSM61	Introduction to Data Science	3	0	0	3	40	60	100
34	PE	21CSM62	Principles of Artificial Intelligence	3	0	0	3	40	60	100
35	PE	21CSM63	Data Warehousing and Data Mining	3	0	0	3	40	60	100
36	PE	21CSM64	Machine Learning Techniques	3	0	0	3	40	60	100
37	PE	21CSM65	Expert Systems	3	0	0	3	40	60	100
38	PE	21CSM66	Cognitive Science	3	0	0	3	40	60	100
39	PE	21CSM67	Gamification	3	0	0	3	40	60	100

21ENT11	COMMUNICATIVE ENGLISH-I	L T P C 3 0 0 3

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-I aims at developing Communication Skills in English essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with necessary listening, speaking, reading and writing skills.

Course Outcomes: Upon completion of the course, students will be able to :

1. Use a wide range of vocabulary in oral and written communication.
2. Use correct grammatical structures in speaking and writing.
3. Write clear and coherent informal Passages.
4. Follow different kinds of spoken excerpts and distinguish relevant from irrelevant information, grasp proper sentence pattern and vocabulary through reading
5. Give short informal presentations and participate in classroom discussions

UNIT 1 VOCABULARY 6

Synonyms and Antonyms- Single Word Substitutes - Use of Abbreviations andAcronyms-Homonyms and Homophones- Business Vocabulary - Commonly Confused Words- Collocation - British and American Vocabulary- Word formation

UNIT 2 GRAMMAR 9

Comparative Adjectives - Modals -Phrasal Verbs -Tenses – Connectives-Impersonal Passive Voice -Types of Questions -Mechanics of Writing (Editing) -Direct and Indirect Speech- Numerical Adjectives - Gerunds and Infinitives-Expressions of Purpose- Conditional Sentences- Same Word Used as Different Parts of Speech – SubjectVerb Agreement

UNIT 3 INFORMAL WRITING 5

Letter Writing - Informal Letters - Dialogue Writing -Informal Dialogues – Essay Writing-Informal Essays Movie/Book Reviews

UNIT 4 LANGUAGE ENHANCEMENT THROUGH LISTENING & READING 9

Listening Comprehension -Listening for General Ideas- Listening to You Tube Documentaries - Listening for Specific Information- Listening for Details-Listening for Vocabulary-BBC Learn English Videos -Reading Comprehension- Understanding General and Specific Information -Sign Post Words-Jumbled Sentences - Finding Topic Sentences and Supporting Arguments - Reading for Vocabulary-Reading News Papers

UNIT 5 LANGUAGE ENHANCEMENT THROUGH SPEAKING 16

Introduction to IPA-Syllable, Stress, Intonation, etc., -Conversation Starters- Describing Places, People, Things and Pictures -Self Introduction - Narrating Personal Experiences and Incidents-Informal Group Discussions

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Sanjay KumarandPushp Lata, “Communication Skills” 2nd Edition, Oxford University Press, New Delhi,2017
2. Raman, Meenakshi and Sangeetha Sharma, “Technical Communication: English Skills for Engineers”, 1st Edition, Oxford University Press, New Delhi. 2008.

REFERENCES:

1. Department of English, Anna University, “Mindscapes: English for Technologists and Engineers”, 1st Edition, Orient Black Swan, Chennai. 2012
2. Dhanavel, S.P, “English and Communication Skills for Students of Science and Engineering”, 1st Edition, Orient Black Swan, Chennai. 2011
3. Rizvi, Ashraf. M, “Effective Technical Communication”, 2st Edition, Tata McGraw-Hill, New Delhi,2018.

e-RESOURCES:

1. http://www.usingenglish.com
2. https://www.khanacademy.org/humanities/grammar

21MAT11 **ENGINEERING MATHEMATICS I** **L T P C**
3 1 0 4

Preamble:

The course aims at achieving conceptual understanding of topics such as Matrix Algebra and Calculus. The syllabus is designed to provide the skills for modeling engineering problems and understand the role of single variable and multivariables in the discipline of engineering and computer science.

Course Outcomes: Upon completion of the course, students will be able to:

1. Evaluate Eigenvalues, eigenvectors and diagonalization of symmetric matrices.
2. Use limit definition, understand differentiation and integration methods.
3. Compute curvature, centre of curvature, evolute and envelope of curves.
4. Express functions of two variables in Taylor's series and compute Jacobians, maximum and minimum values.
5. Apply multiple integrals to determine area in cartesian and polar coordinates and volume in cartesian co ordinates.

UNIT 1 MATRICES **9+3**

Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Statement and application of Cayley Hamilton Theorem – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 CALCULUS **9+3**

Representation of functions – Mathematical Models – New Functions from Old Functions – Graphing Calculators and Computers – The Limit of a Function – Calculating Limits Using the Limit Laws – Continuity – Exponential Growth and Decay – Hyperbolic Functions – Areas and Distances – The Definite Integral – The Fundamental Theorem of Calculus – Improper Integrals.

UNIT 3 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS **9+3**

Curvature – Radius, Centre and Circle of curvature in Cartesian and Parametric form - Evolute – Envelope of family of curves with one and two parameters – Evolute as the envelope of normals – Properties of Evolute and Envelope.

UNIT 4 FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian- Properties – Taylor's series expansion for functions of two variables – constrained Maxima and Minima – Lagrange's multipliers with single constraint.

UNIT 5 MULTIPLE INTEGRALS **9+3**

Double integrals in Cartesian and Polar co ordinates- Change of order of Integration – Change of variables from Cartesian to Polar co ordinates – Area as a double integral in Cartesian and Polar form – Volume as a triple integral in Cartesian co ordinates

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [Sections 1.1, 1.2, 1.3, 1.4, 2.2, 2.3, 2.5, 3.8, 3.11, 5.1, 5.2, 5.3 and 7.8].

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. N.P.Bali,Manish Goyal, "Engineering Mathematics",Lakshmi Publications(PVT) Ltd,4 th edition,2014

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/"Advanced Engineering Mathematics", Prof. Pratima Panigrahi, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/122104017/ " Mathematics-I", Prof. S.K. Ray, Indian Institute of Technology, Kanpur

21PHT11 **ENGINEERING PHYSICS** **L T P C**
3 0 0 3

Preamble:
Ultrasonics forms the basis of Sonar and in the field of medicine for both diagnostics and therapeutic applications. Mechanical properties of Engineering materials are explored for industrial applications such as construction of bridges and railway wagons. Particle and wave nature of quantum particles form the basis of quantum computers .The virtues of lasers are explored in applications such as holography, computers ,space satellites and medicines.

Course Outcomes: Upon completion of the course, students will be able to:

1 Demonstrate the knowledge of wave optics in propagation of light waves in optical fibers in communications system.
2 Explain the production of Ultrasonics and its NDT techniques in scanning methods, medical applications.
3 Describe the Elastic property of solid materials and thermal conductivity of solids in industrial applications.
4 Explore the dual nature of light waves with quantum theory on Black body radiation and Schrodinger's wave equations.
5 Demonstrate the knowledge on Nd-YAG, CO_2, Semiconductor lasers in industrial applications of welding, heat treatment, cutting, medical treatment and holography.

UNIT 1 WAVES AND OPTICS **9**

Classification of waves-wave equation-(qualitative)-Typical and General wave equation-qualitative analysis of phase and group velocities of waves-Differential equation of simple harmonic motion-Forced oscillations –analysis and classification of damped oscillations through differential equations-coherent sources and incoherent sources.
Superposition principle of Waves- Illustrations-Principle and propagation of light in optical fibers-numerical aperture and acceptance angle-Types of optical fibers (material, refractive index, mode-Application of optical fibers.

UNIT 2 ULTRASONICS **9**

Introduction – Production techniques– Magnetostriction effect– Piezoelectric effect - Piezoelectric generator- detection of ultrasonic waves - properties – cavitations - velocity measurement – acoustic grating - Industrial applications – drilling, welding, soldering and cleaning – SONAR - non destructive testing – pulse echo system, through transmission and reflection modes - A,B and C scan - medical applications - sonograms.

UNIT 3 MECHANICAL AND THERMAL PROPERTIES **9**

Elasticity – Stress-strain diagram and its uses – factors affecting elastic modulus and tensile strength. Torsional stress and deformations – twisting couple – torsion pendulum: theory and experiment – bending of beams. Bending moment – cantilever, Young's Modulus by Uniform and non-uniform bending: theory and experiment – I-shaped girders.
Modes of heat transfer -thermal conductivity- Specific heat-Newton's law of cooling - Forbe's and Lee's disc method: theory and experiment– thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters

UNIT 4 MODERN PHYSICS **9**

Wave- particle duality, de-Broglie matter waves, Davisson-Germer experiment, Heisenberg uncertainty principle and its applications, Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory — Matter waves – concept of operator-Eigen value and Eigen function- Physical significance of wave function -Schrodinger's time independent wave equation — Particle in a one dimensional box ,qualitative explanation on wave equation and energy value in three dimensional box.

UNIT 5 LASER **9**

Introduction – principle of spontaneous emission and stimulated emission, population inversion, pumping. Einstein's coefficients - derivation. Types of lasers- Nd-YAG-CO_2, Semiconductor lasers (homojunction & heterojunction) – Industrial applications - lasers in welding, heat treatment, cutting- medical applications- holography-construction and reconstruction-Safety classes of laser.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai publishers, 2009.
2. Mani Naidu S., "Engineering Physics", 2nd Edition, Pearson Publishing, 2011.

REFERENCES

1. Serway and Jewett, "Physics for Scientists and Engineers with Modern Physics", 9th Edition, Thomson Brooks Cole, 2013
2. Young H.D., Freedman R.A. and Ford A.L., "Sears and Zemansky's University Physics with Modern Physics", 13th Edition, Pearson India, 2013.
3. Tipler P.A. and Mosca G.P., "Physics for Scientists and Engineers with Modern Physics", 6th Edition, W.H.Freeman, 2007.

e-RESOURCES:

1. http://nptel.ac.in/courses/115101003 , "Atomic and Molecular Physics" – Dr. T. Kundu, IIT Bombay.

21CYT11 **ENGINEERING CHEMISTRY** **L T P C**

3 0 0 3

Preamble:

The study of water technology enables engineers to acquire skills to make the simple design calculation of drinking water as well as industrial water treatment. Electrochemistry and corrosion explain the fundamentals, corrosion prevention, identification and implementation for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage technologies. Instrumental methods and analysis describe basic concepts and promote to solve real analytical problems. Studies of Nanochemistry span many areas as assemblies significant new structures like nanowire, nanotube and lab-in-chip devices.

Course Outcomes: Upon completion of the course, students will be able to:

1. Evaluate the process to purify hard water using ion-exchange, zeolite and reverse osmosis methods.
2. Compare and contrast corrosion control methods and analyze the performance of alkaline, lead acid and fuel cells.
3. Analyze the metal ion concentration for solid and liquid samples with the aid of flame photometry, colorimetry, UV and IR spectroscopy.
4. Categorize different types of polymers to select injection or compression fabrication method.
5. Analyze the synthesis of nanoparticles using top down and bottom up process.

UNIT 1 WATER TECHNOLOGY **9**

Hardness – types, estimation by EDTA method, Boiler troubles – scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion, Internal conditioning - carbonate, phosphate and calgon conditioning, External conditioning – zeolite and demineralisation process, Desalination – reverse osmosis method.

UNIT 2 ELECROCHEMISTRY AND CORROSION **9**

Electrochemistry –cell terminology, EMF series. Corrosion – chemical (corrosion by O_2, H_2 and liquid-metal) and electrochemical corrosion (H_2 evolution and absorption of O_2), Corrosion control – sacrificial anode, Impressed current method and electroless plating.

Application of electrochemistry-primary battery (alkaline battery), secondary battery (lead acid battery) and fuel cell (H_2-O_2 fuel cell)

UNIT 3 INSTRUMENTAL METHODS AND ANALYSIS **9**

Basic principles – Beer-lamberts law, instrumentation with block diagram and applications of calorimetry (estimation of Fe^{2+}), UV-Visible spectroscopy, infrared spectroscopy and flame photometry (estimation of sodium).

UNIT 4 HIGH POLYMERS **9**

Polymers – classification (based on molecular forces-thermoplastics and thermosetting plastics), polymerisation – types, mechanism (Free radical only),Compounding and fabrication – compression, injection, Composites-definition, types, polymer matrix composites-FRP only.

Real time applications of thermoplastics (PVC, Teflon), thermosetting plastics (nylon, epoxy resin)

UNIT 5 NANOCHEMISTRY **9**

Basics – distinction between molecules, nanoparticles and bulk materials, Nanoparticles – nano cluster, nano rod, nanotube (CNT) and nanowire, Synthesis – top down process (laser ablation and electro-deposition),bottom up process (thermolysis – hydrothermal, solvothermal), Nanoparticles –properties and applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. P.C Jain and Monika Jain, "Engineering Chemistry", 16th edition,DanpatRai publishing company (P) Ltd, New Delhi, 2015
2. N. Krishnamurthy, P. Vallinayagam and D. Madhavan, "Engineering Chemistry", 3rd edition. PHI Learning PVT., LTD, New Delhi, 2014.

REFERENCES:

1. S.S.Dara, "A Text book of Engineering Chemistry", 12th Edition, S.Chand & Company Ltd., New Delhi, 2010.
2. "Engineering chemistry", 2nd edition, Wiley India private Ltd. New Delhi, 2014.
3. V.R.Gowariker, N.V.Viswanathan and Jayadevsreedhar, "Polymer Science" 2nd edition, New age International publishers, New Delhi, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/113104061/ ,"Environmental Degradation of Materials" - Dr.KallolMondal, Department of Metallurgy and Material Science, IIT Kanpur
2. http://nptel.ac.in/courses/113105028/ **,** "Science and Technology of Polymers"- Prof.B.Adhikari, Department of Metallurgical & Materials Engineering,IITKharagpur

21EET11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

Preamble:
The course covers the fundamentals of basic electrical circuit parameters of both ac and dc circuits and the characteristics of motors and generators. The basics of semiconductor devices and logic gates provides the necessary initiative for the students to acquire the knowledge in basic electronics.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1 Analyze the various DC circuits and find the circuit parameters.
2 Describe the principles of AC fundamentals.
3 Illustrate the construction and working principle of DC machines.
4 Explain the basics of semiconductor devices and its applications.
5 Explain the basics of Number systems and Logic gates.

UNIT 1 ELECTRICAL CIRCUITS – DC 9

Definition of Electrical Circuit Parameters - voltage – current - power and energy. Elements of DC Circuits - DC voltage / Current Sources. Calculation of Resistance and Current in series and parallel circuit– Star-Delta transformation of Resistance. Ohm's Law, Kirchhoff's Laws and its applications - Simple Problems in Mesh and Nodal analysis. Construction and working principle of Permanent Magnet Moving Coil Instruments.

UNIT 2 ELECTRICAL CIRCUITS – AC 9

AC Circuit Terminologies - RMS and Average value of Sinusoidal waveform – Form Factor - Peak Factor - Power Factor - Definition of impedance and admittance – Phasor diagram - Analysis of R, L, C, RL, RC, RLC circuits. Construction and working principle of Moving iron Instruments. Introduction to Three phase system - Star and Delta Connection.

UNIT 3 ELECTRICAL MACHINES 9

Review of Laws of Electromagnetic Induction – Fleming's Right and Left hand rules – Lenz's law. DC Generator - Construction - Working principle - Characteristics of DC Shunt Generator. DC Motor - Construction - Working principle – Characteristics and applications of DC Shunt Motor - AC transmission and distribution system (Single line diagram).

UNIT 4 SEMICONDUCTOR DEVICES AND APPLICATIONS 9

PN junction Diode and its Characteristics - Zener Diode and its Characteristics – Half and Full wave Rectifiers – Voltage regulation. Bipolar Junction Transistor - CE configuration and its characteristics – BJT as an amplifier.

UNIT 5 DIGITAL ELECTRONICS 9

Boolean Algebra - Theorems and Laws - De-Morgan's theorem – Logic Gates – Universal Gates - Implementation of Boolean functions. Binary Arithmetic - Addition – Subtraction – Multiplication - Division – BCD addition - Half adder and Full adder circuits.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Muthusubramanian R and Salivahanan S, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 1st Edition, 2014.
2. Mittle V N and Aravind Mittal, "Basic Electrical engineering", McGraw Hill Education, 2nd Edition, 2006.

REFERENCES:

1. V.K.Mehta and Rohit Mehta, "Principles of Electrical Engineering and Electronics", S.Chand & Company Ltd, 2015.
2. Sedha R.S.,"Applied Electronics",S.Chand & Company Ltd,2006.
3. Thomas L.Floyd.,"Digital Fundamentals",Pearson Education,Prentice Hall,Tenth Edition,2010.

E-RESOURCES:

1. NPTEL, http://nptel.ac.in/courses/117106101/ , "Basic Electrical Circuits", Prof. Nagendra Krishnapura, IIT, Madras.
2. NPTEL, http://nptel.ac.in/downloads/108105053/ , "Basic Electrical Technology", Prof. Dr. L. Umanand, IIS, Bangalore.
3. NPTEL, http://nptel.ac.in/courses/117103063/ , "Basic Electronics", Dr. Chitralekha Mahanta, IIT, Guwahati.

21MEC11 **ENGINEERING GRAPHICS** **L T P C**

2 0 4 4

Preamble:

The knowledge of Engineering graphics is essential for the Engineering graduates in proposing new product designs through drawings and interpreting data from existing drawings. Engineering Design inculcates into an Engineer the creativity and knowledge on various aspects to be considered while designing and realizing the functional products and processes. This course deals with Engineering curves, orthographic and pictorial projections, sectional views and development of surfaces.

Course Outcomes: Upon completion of the course, students will be able to:

1. Draw the various conic sections and Engineering curves.
2. Sketch the orthographic views from given pictorial views and projections of lines.
3. Draw the projections of planes and solids kept in various positions.
4. Sketch sectioned views of solids and development of surfaces.
5. Draw the isometric and perspective projections of simple solids.

UNIT 1 INTRODUCTION AND PLANE CURVES 12

Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lines, lettering and dimensioning-Basic geometrical constructions. (PRACTICE ONLY AND NOT FOR EXAMINATIONS).

Curves used in Engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT 2 PROJECTION OF POINTS, LINES AND FREE HAND SKETCHING 12

Orthographic projection- principles-Principal planes-First angle projection- Projection of points in four quadrants - End point projection of straight lines (only First angle projections) inclined to both the principal planes -Determination of true lengths and true inclinations by rotating line method.

Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views.

UNIT 3 PROJECTION OF PLANE SURFACES AND SOLIDS 12

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Projection of simple solids- Cube, prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane and parallel to the other by rotating object method.

UNIT 4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 12

Sectioning of above solids in simple vertical position when cut by a cutting plane which is inclined to one of the reference planes and perpendicular to the other – Obtaining true shape of section.

Development of lateral surfaces of simple and truncated solids in simple vertical position – Cube, prisms, pyramids, cylinder and cone.

UNIT 5 ISOMETRIC AND PERSPECTIVE PROJECTIONS 12

Principles of isometric projection – Isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinder and cone- Combination of two solid objects in simple vertical position.

Perspective projection of simple solids-Cube, prisms, pyramids, cylinder and cone, by visual ray method when axis is either parallel or perpendicular to ground plane.

TOTAL : 60 PERIODS

TEXT BOOKS:

1 Venugopal K and Prabhu Raja V., "Engineering Graphics", New Age International (P) Ltd, 13th Edition, 2015.

2 Jeyapoovan T. , "Engineering Graphics with AUTOCAD", Vikas Publishing House Pvt., Ltd., 7th Edition, 2015.

REFERENCES:

1 Bhatt N.D., Panchal, V.M. and Ingle P.R., "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd Edition, 2014.

2 Parthasarathy N.S. and Vela Murali, "Engineering Drawing", Oxford University Press, 1st Edition, Second Impression 2015.

3 Luzzader W..J. and Duff J.M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

e-RESOURCES:

1. http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. Nihar Ranjan Patra , IIT Kanpur
2. http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr. Velamurali

Preamble:

In the present course related to the lab, understanding of physics concepts applied in optics, thermal and properties of matter has been developed. The necessary practical skills in the determination of water quality parameters and strength of acid has been explored.

Course Outcomes:

1. Experiment and determine the physical characteristics of given solid materials.
2. Experiment and determine the velocity of ultrasonic waves through water medium.
3. Experiment and determine the optical property of light sources.
4. Experiment and estimate hydroxyl, carbonate and bicarbonate alkalinity using HCl in water sample.
5. Experiment and determine the amount of total, temporary, permanent hardness of water using EDTA by complexometric titration.
6. Experiment and determine the amount of iron content present in the given sample using potentiometer, spectrophotometer and strength of acid using conductivity meter.

PHYSICS LABORATORY – I

(Any Five Experiments)

LIST OF EXPERIMENTS

1. (a) Determination of Wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of Planck's constant by photocell method

CHEMISTRY LABORATORY – I

LIST OF EXPERIMENTS

1. Determination of alkalinity in water sample
2. Determination of total, temporary and permanent hardness of water by EDTA method.
3. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline /thiocyanate method).
4. Determination of iron content of the given solution using a potentiometer
5. Determination of strength of acid using conductivity meter.

TOTAL : 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

21MEL11 **WORKSHOP PRACTICES LABORATORY** **L T P C**
0 0 3 1

Preamble:

Workshop practices give hands-on training practice to Engineering students. This course includes carpentry, plumbing, welding, sheet metal forming and welding exercises. Also, this course will inculcate in the students the habit of selecting right tools, planning the job and its execution.

Course Outcomes: Upon completion of the course, students will be able to:

1. Fabricate various joints by carpentry and to prepare plumbing line assemblies.
2. Fabricate various joints through arc welding and gas welding processes.
3. Perform metal forming and basic machining operations.
4. Construct various types of domestic wiring and measure the various electrical parameters.
5. Develop and test circuits with active elements and verify truth table of logic gates.

GROUP A

CIVIL **9**

Plumbing Works:

- Study of plumbing tools, pipeline joints, its location, functions and safety aspects.

1. a. Distribution of water from sump to overhead tank and return to home tap with bye pass connection.
   b. Distribution of water in mixed pipes.

Carpentry using Power Tools only:

- Study of the carpentry tools, joints and processes in roofs, doors, windows and furniture and safety precautions.

Hands-on-exercise:

1. Tee Lap joint
2. Dove tail joint

MECHANICAL **15**

Welding:

1. Arc welding - Lap joint
2. Arc welding - Tee joint

Basic Machining:

3. Simple Turning and Facing
4. Drilling and Tapping

Sheet Metal Work- Forming & Bending:

5. Model making - Tray / Funnel

Study Experiments:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration:

- Gas welding practice

GROUP B

ELECTRICAL **12**

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Reading of voltage, current, power, energy and other parameters with 1 phase digital energy meter.
5. Measurement of earth resistance.

ELECTRONICS **9**

1. Identification and Study of Electronic components and equipments – Resistors, capacitors, inductors, colour coding and measurement.
2. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
3. Verification of the truth tables of logic gates: AND, OR, XOR and NOT.
4. Construction of Half Wave and Full Wave Rectifiers and study their output waveforms.
5. Soldering practice – Using general purpose PCB.

TOTAL : 45 PERIODS

REFERENCES: Manual prepared by the faculty of Mechanical Engineering Department, VCET.
e-RESOURCES: http://vlabs.iitkgp.ernet.in/be/#

21MCL11 **UNIVERSAL HUMAN VALUES – I** **L T P C**
1 0 1 0

Preamble:
Universal Human Values is a life skill necessary for all to develop physical health and factors for strengthening life force. This course aims to expose the students in the areas of mediation and impart the knowledge on social virtues and morals.

Course Outcomes: Upon completion of the course, students will be able to:
1. Demonstrate the knowledge on physical health
2. Discuss the factors for strengthening life force
3. Classify mind waves and explain the benefits of meditation
4. Explain individual and social virtues
5. Identify and explain the importance of morals.

UNIT 1 Physical Health **6**

SKY – Introduction – Education as a means for youth empowerment – Greatness of Education – Yoga for Youth Empowerment – Simplified Physical Exercises: Explanation – Hand, Leg, Breathing and Eye exercises – Kapalabathi, Makarasanam, Massaging, Acupressure and Relaxation practices –Yogasanas- Explanation – Benefits.

UNIT 2 Strengthening Life Forces **6**

Reasons for Diseases: Natural Reasons (Hereditary, Planetary Position, Natural Calamities and Climatic changes) – Artificial Reasons (Food, Thought, Deed). Philosophy of Kayakalpa: Physical Body –Life Force – Biomagnetism – Mind. Maintaining Youthfulness – Postponing Aging – Transformation of Food into seven Body constituents.

UNIT 3 Wellness of Mind **6**

Classification of Mind Waves – Beta, Alpha, Theeta, Delta – Agna Meditation – Benefits. Shanthi Mediation – Benefits. Thuriya Meditation – Benefits. Blessing and its Benefits: Auto Suggestion – Blessing the family and others – Blessings the World – Divine Protection.

UNIT 4 Virtues **6**

Individual Virtues: Self Control – Self Confidence – Speaking Truth – Contentment – Humility – Mind Control. Tolerance – Adjustment – Sacrifice – Forgiveness. Cleanliness (Body, Dress, Surrounding)-External, Mental, Inner Cleanliness. **Societal Virtues:** Ahimsa – Services, Patriotism – Equality, Respecting the parents and elders – Caring for them – Respecting Teachers. Punctuality – Time Management.

UNIT 5 Morals **6**

Importance of introspection: I and Mine (Ego, Possessiveness), Six Temperaments: Greed – Anger – Miserliness – Immoral Sexual Passion – Inferior Superior complex – Vengeance. Maneuvering the Six Temperaments: Contentment – Tolerance – Charity – Chastity – Parity – Forgiveness. Five important Benefits of Meditation: Perspicacity – Magnanimity – Adaptability – Receptivity – Creativity. (Enhancing memory) (Effective Examination Preparation).

TOTAL : 30 PERIODS

TEXT BOOKS:
1. "Yoga for Youth Empowerment" compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi, 1st Edition 2016.
2. "Yoga for Human Excellence", compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi 1st Edition 2009.

e-RESOURCE:
1. www.online.vethathiri.edu.in "online in (Virtual) Programme on Yoga and Human Excellence".

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-II aims at developing Communication Skills in English essential for expressing the ideas through speaking and writing in different social, academic and professional contexts.

Course Outcomes: Upon completion of the course, students will be able to:

1. Start, maintain and close a conversation in a variety of contexts including formal/informal and telephonic conversation.
2. Use structurally correct expressions and conversations.
3. Speak fluently using phrasal verbs and Idiomatic Expressions by recognizing and rectifying own pronunciation and intonation problems.
4. Speak fluently using a wide range of vocabulary.
5. Communicate effectively by using business correspondence structures.

UNIT 1 EFFECTIVE SPEAKING -BASIC LANGUAGE CHUNKS 10

Conversational Starters – Closing a Conversation - Greeting and Leave Taking - Introducing Oneself - Introducing Others - Making Request - Offering Help - Expressing Gratitude -Extending Invitation - – Conveying Wishes – Encouraging Words -Seeking Permission – Granting Permission-Making Complaints - Seeking Apology - Making Interruption - Expressing Possibility- Expressing Agreement and Disagreement - Expressing Hesitation -Asking for Directions and Giving Directions - Giving Instructions- Questions and Expressions with Time – Checking for Understanding -Showing Interest -Expressing Likes and Dislikes

UNIT 2 EFFECTIVE SPEAKING –ADVANCED LANGUAGE CHUNKS 10

Expressing Personal Opinion - Expressing Feelings - Accepting Responsibility - Giving Clarifications - Tag Questions - Giving Comments – Giving Advice – Making Suggestions- –Making Comparisons – Analyzing Problems- Exploring Options – Making Classifications and Elaborations - Speaking Hypothetically-- Discussing Plans-Making Negotiations-Making Presentations-Telephone Etiquette - Telephone Conversation

UNIT 3 EFFECTIVE SPEAKING - PHRASAL VERBS AND IDIOMATIC EXPRESSIONS 3

Most useful Phrasal Verbs related to Self-Introduction-Idiomatic Expressions related to Person, Time and Action

UNIT 4 EFFECTIVE SPEAKING – VOCABULARY ENRICHMENT 10

Talking about Abilities – Travel – Shopping – Climate -Commuting – Distance – Food – Occupation – Parties and Festivals – Daily Routine – Clothing – Hobbies – Favorites- Family – Buying and Selling- Schedules and Plans

NIT 5 BUSINESS WRITING 12

Writing Instructions - Recommendations - Checklist - Tour Itinerary -Writing Slogans - E- mail Writing - Single Line Definitions - Process Description – SMS - Transcoding Graphics - Bar Chart, Flow Chart, Pie Chart and Tables - Business Letters - Calling for Quotations, Placing Orders, Letter of Complaint, Letter of Clarification - Agenda and Meeting Minutes - Cover Letter with Résumé - Report Writing - Accident Report, Industrial Visit Report, Survey Report and Feasibility Report- Summary Writing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sanjay KumarandPushp Lata, “Communication Skills” 2nd Edition, Oxford University Press, New Delhi.2017.
2. J.K.Gangal, “A Practical Course in Spoken English” 1st Edition PH1 Learning Private Limited, Delhi,2014.

REFERENCES:

1. Dr K Elango, Dr. Veena Selvam, Dr. Sujatha Priyadarshini, “Resonance English for Engineers and Technologists”.Cambridge University Press, 1st Edition, Foundation Books,New Delhi, 2013.
2. Dr.MahendraSarawat, “Speak English Fluently” UpkarPrakashan Publishers, 1st Edition,Agra,2010.
3. S.Sumant,Joyce Pereira, “Technical English”,Vijay Nicole imprints Private Limited,1st EditionChennai,2017.

e-RESOURCES:

1. https://www.fluentu.com/Blog/english/english-small-talk/
2. http://www.britishcouncil.com

21MAT21 **ENGINEERING MATHEMATICS – II** **L T P C**
3 1 0 4

Preamble:
Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. Complex Integration approach is very useful to evaluate many improper integrals of a real variable. The Laplace transform method is a powerful method for solving linear ODEs and corresponding initial value problems as well as systems of ODEs arising in Engineering. The knowledge of transformations is to create a new domain in which it is easier to handle the problem that is being investigated.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compute gradient, directional derivative by vector differentiation and determine line integrals, surface integrals and volume integrals by vector integration.
2. Construct analytic functions and transforms the analytic functions from one domain to another using conformal mapping.
3. Classify the singularities, find Laurent's series for analytic functions and compute complex integrals using Cauchy's integral theorem and Cauchy's Residue theorem.
4. Solve linear higher order differential equations with constant and variable coefficients.
5. Solve linear second order ordinary differential equations with constant coefficients using the properties of Laplace Transforms.

UNIT 1 VECTOR CALCULUS **9+3**

Vector Differentiation: Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration: Line, Surface and Volume Integrals -Green's theorem in a plane, Gauss Divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

UNIT 2 ANALYTIC FUNCTIONS **9+3**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions by Milne's method – Conformal mapping:
w = z+k, kz, 1/z and bilinear transformation.

UNIT 3 COMPLEX INTEGRATION **9+3**

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proof) – Taylor's and Laurent's series expansions – Singularities – Residues – Cauchy's residue theorem(excluding proof) – Application of residue theorem to evaluate real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis)

UNIT 4 ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Linear higher order differential equations with constant coefficients – Method of variation of Parameters – Cauchy's and Legendre's linear differential equations – Simultaneous first order linear differential equations with constant coefficients.

UNIT 5 LAPLACE TRANSFORMS **9+3**

Laplace transform: Sufficient conditions – Transform of elementary functions – Basic Properties – Transforms of derivatives and integrals of functions — Transform of periodic functions
Inverse Laplace transform: Standard results – Statement of Convolution theorem and its applications – Initial and final value theorems – Solution of linear second order ODE with constant coefficients using Laplace transformation techniques.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics'', Khanna Publishers, 43rd Edition, New Delhi, 2014.
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016

REFERENCES:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Veerarajan T., "Engineering Mathematics (I Year)", 3 rd Edition, Tata McGraw Hill Publishing Company, Delhi, 12.
3. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Higher Engineering Mathematics", S.Chand & Co Ltd, Chennai,2016.

e-RESOURCES:

1. http://nptel.ac.in/courses/122107036/ "Mathematics-II", Prof. Tanuja Srivastava, Department of Mathematics, Indian Institute of Technology, Roorkee.
2. http://nptel.ac.in/courses/122107037/ "Mathematics – III", Prof. Dr. P. N. Agrawal , Indian Institute of Technology, Roorkee

21PHT21 **MATERIALS SCIENCE** **L T P C**

3 0 0 3

Preamble:

A Knowledge about the electronic structure of metals, semiconductors and dielectrics has manifested us a technology to design materials of desired properties. The properties of superconductors, magnetic materials and engineering materials like metallic glasses, shape memory alloys, biomaterials and nanomaterials has emerged as a technology, contributing to advances in medicine ,electronics,astronomy,transportation and experimental science.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the behaviour of conducting materials based on classical and Quantum theory.
2. Demonstrate the knowledge of semiconductors with their carrier concentration and hall effect.
3. Describe the types of magnetic material and applications of superconducting materials.
4. Discuss the types of Polaraisation, breakdown and the applications of Dielectric materials.
5. Explain the preparation, properties and applications of metallic glasses, Shape memory alloy, Nanomaterials and Biomaterials.

UNIT 1 CONDUCTING MATERIALS **9**

Conductors – Classical free electron theory of metals – Electrical and thermal conductivity -Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory –Fermi distribution function – Effect of temperature on Fermi function – Density of energy states –Carrier concentration in metals.

UNIT 2 SEMICONDUCTING MATERIALS **9**

Intrinsic semiconductor – Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – Electrical conductivity – Band gap determination –Types of semiconductor- Derivation of carrier concentration in n-type and p-type semiconductor– Variation of Fermi level with temperature and impurity concentration — Hall effect – Determination of Hall coefficient – Applications.

UNIT 3 MAGNETIC AND SUPERCONDUCTING MATERIALS **9**

Origin of magnetic moment – Bohr magneton – Comparison of dia, Para and Ferro magnetism –Langevin theory of Paramagnetism(Qualitative) -Domain theory – Hysteresis – Soft and hard magnetic materials – Antiferromagnetic materials.

Superconductivity : Properties – Type I and type II superconductors –BCS theory of superconductivity(qualitative) – High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT 4 DIELECTRIC MATERIALS **9**

Electrical susceptibility – Dielectric constant – Electronic, ionic, orientational and space charge polarization – Debye equation-Frequency and temperature dependence of polarisation – Internal field – Claussius –Mosotti relation (derivation) – Dielectric loss – Dielectric breakdown – Uses of dielectric materials (capacitor and transformer) – Ferroelectricity and applications.

UNIT 5 ADVANCED ENGINEERING MATERIALS **9**

Metallic glasses: Preparation, properties and applications – Shape memory alloys (SMA): Characteristics, properties of Ni-Ti alloy, applications –Concept of Nanomaterials – Synthesis routes – Pulsed laser deposition – Chemical vapour deposition – Applications – Role of Polymers and Composites.

TOTAL : *45* PERIODS

TEXT BOOKS:

1. Palanisamy P.K, “Materials Science”, 2nd Edition, Scitech publications (India) Pvt. Ltd., Chennai, 2007.
2. S.O.Pillai “Solid State Physics”,6th Edition,New Age International(P) Ltd,Publishers New Delhi,2010.

REFERENCES:

1. Balasubramaniam R, “Callister's Materials Science and Engineering”, 2nd Edition, Wiley-India 2014.
2. Richard J.D.Tilley,”Understanding Solids”,2nd Edition, John Wiley&Sons –India, 2013
3. Charles P. Poole and Frank J.Owens, “Introduction to Nanotechnology”, 1st Edition, Wiley, New Delhi, 2007.

e-RESOURCES:

1. http://nptel.ac.in/courses/122102008 , “Materials Science” – Dr. S. K. Gupta, IIT Delhi
2. https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields

Preamble:
Python is easy to use, powerful, and versatile, making it a great choice for beginners and experts alike. Python's readability makes it a great first programming language — it allows you to think like a programmer and not waste time understanding the mysterious syntax that other programming languages can require. The syntax in Python helps the programmers to do coding in fewer steps**.**Python is widely used in bigger organizations because of its multiple programming paradigms.

Course Outcomes: Upon completion of the course, students will be able to:

1. Develop algorithms, flowcharts and pseudo codes for a given problem.
2. Develop Python programs usingdecision control statements for solving given problems.
3. Develop functions, modules and packages using Python for solving given problems.
4. Write programs using stringhandling features in Python for solving given problems.
5. Create Python programs using list, tuple, dictionaries and sets to solve given problems.

UNIT 1 INTRODUCTION 9

Generation, Characteristics and Classification of Computers – Organization of Computers – Problem Solving Strategies – Program Design Tools: Algorithms, Flowcharts and Pseudocodes – Types of Errors.

UNIT 2 DATA TYPES AND CONTROL STATEMENTS 9

Features of Python – Literal Constants – Variables and Identifiers – Data Types – Input operation – Comments – Reserved words – Indentation – Operators and Expressions – Expressions in Python – Operations on Strings – Type conversion – Decision Control Statements: Selection / Conditional Branching – Loop Structures / Iterative Statements – Nested Loops – break – continue – pass – else statements.

UNIT 3 FUNCTIONS, MODULES AND PACKAGES 9

Need for functions – Function definition – Function call – Variable Scope and lifetime – return statement – function arguments : required, keyword, default and variable length arguments–Lambda functions – recursive functions – modules – packages in Python – Standard library modules – function redefinition.

UNIT 4 STRING, LIST AND SET 9

String manipulations – String formatting – built in methods and functions – slice operation – string comparison and iteration. List: Basic list operations – nested lists – cloning lists – List methods – Looping in lists. Sets: Creating sets – set operations.

UNIT 5 TUPLES , DICTIONARY AND FILES 9

Tuples: Creating and accessing values – Basic Tuple operations – Tuple assignment – tuples returning multiple values – nested tuples. Dictionary: Creating and Accessing values – Sorting –Looping – Dictionary functions and methods. File: Types of files – opening, closing, reading and writing files.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist‘‘, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Reema Thareja, “Python Programming using Problem Solving Approach”, Oxford University Press, 2017.

REFERENCES:

1. Guido van Rossum and Fred L.Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2”, Network theory ltd., 2011.
2. John V Guttag, ―Introduction to Computation and Programming Using Python‘‘, Revised and expanded Edition, MIT Press , 2013.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

e-RESOURCES:

1. https://swayam.gov.in/course/4178-spoken-tutorial-python-english,”Introduction to Python”, Prof. Prabhu Ramachandran, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc18_cs21, “Programming, Data Structures And Algorithms Using Python”, Prof.Madhavan Mukund, IIT-Bombay.

21MET21 **ENGINEERING MECHANICS** **L T P C**
3 2 0 4

Preamble:

Engineering Mechanics deals with the state of rest or motion of the bodies subjected to the action of forces. This course is mainly concerned about the rigid body mechanics, which forms the basis for the design and analysis of the various structural and mechanical devices encountered in Engineering. This course is subdivided into Statics and Dynamics. Statics deals with the study of bodies under rest or uniform motion while Dynamics deals with the bodies under accelerated motion.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the static equilibrium of particles under the influence of forces.
2. Draw free body diagrams and to solve problems related to the static equilibrium of rigid bodies.
3. Locate the centroid of plane areas and centre of mass of solids and to compute moment of inertia.
4. Demonstrate the knowledge on friction and its influence on the equilibrium of bodies.
5. Determine the displacement, velocity and acceleration of the rigid bodies subjected to dynamic forces.

UNIT 1 BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT 2 EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – 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 – Varignon's theorem – Single equivalent force - Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT 3 PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas, T section, I section, - Angle section, Hollow section by using standard formulae – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas, T section, I section, Angle section, Hollow section by using standard formulae. Parallel axis theorem and perpendicular axis theorem – Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle.

UNIT 4 FRICTION 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction, ladder friction, screw friction, belt friction, Rolling resistance.

UNIT 5 DYNAMICS OF PARTICLES AND RIGID BODIES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion –Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Beer F.P et.al., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 10th Edition, Tata McGraw Hill Education India Pvt. Ltd., New Delhi, 2014.
2. Kumaravelan R. and Yugananth P., "Engineering Mechanics", 2nd Edition, Scitech Publications, 2015.

REFERENCES:

1. Vela Murali, "Engineering Mechanics", 1st Edition 11th Impression, Oxford University Press, 2016.
2. Timoshenko S, Young D H , SukumarPati and Rao J V, "Engineering Mechanics (in SI Units)" , 5th Edition, McGrawhill Education, 2013.
3. Kottiswaran N., "Engineering Mechanics Statics and Dynamics", 10th Edition, Sri Balaji Publications Pvt. Ltd., 2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/122104015. Engineering Mechanics - Prof. Manoj K Harbola ,IIT Kanpur.
2. https://www.coursera.org/course/statics1

Preamble :

The understanding of characteristics of solids and liquids and properties of semiconducting materials has been explored. The practical skills in the instrumental methods for quantitative estimation of metal ions content has been the main focus.

Course Outcomes:

1. Experiment and determine the physical characteristics of given solid material.
2. Experiment and determine the Energy band gap of the given semiconducting materials.
3. Experiment and determine the physical characteristics of given liquid.
4. Experiment and estimate dissolved oxygen content using alkali iodide solution by Winkler's method, amount of copper content using EDTA by complexometric titration.
5. Experiment and test chloride content present in the waste water by titrating against silver nitrate using Mohr's method.
6. Experiment and determine the concentration of metals and ions present in the wastewater with the aid of flame photometer and pH meter.

PHYSICS LABORATORY II
(Any Five Experiments)

LIST OF EXPERIMENTS

1. Determination of Young's modulus by uniform bending method.
2. Determination of band gap of a semiconductor.
3. Determination of coefficient of viscosity of a liquid – Poiseuille's method.
4. Determination of thickness of a thin wire – Air wedge method.
5. Determination of rigidity modulus – Torsion pendulum.
6. Determination of Hysteresis of a ferromagnetic material –Deflection magnetometer

CHEMISTRY LABORATORY II

LIST OF EXPERIMENTS

1. Determination of Dissolved Oxygen content of waste water sample by Winkler's method
2. Determination of chloride content of wastewater sample by Argentometric method.
3. Determination of acid strength in waste water using pH meter.
4. Estimation of dissolved metal ions present in wastewater using flame photometer.
5. Estimation of dissolved metal ions(copper) present in wastewater byEDTA method.

TOTAL : 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

21CSL21	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L T P C 0 0 3 1

Preamble:
Python is a dynamic and powerful programming language that focuses on code readability. The Python language has diversified application in the software development companies such as in gaming, web frameworks and applications, language development, prototyping, graphic design applications, etc. This provides the language a higher plethora over other programming languages used in the industry.
Course Outcomes: Upon completion of the course, students will be able to:

1. Create documents, presentation slides and perform data manipulations using Libre Office packages for a given scenario.
2. Write, test and debug simple programs using expressions and statements in Python.
3. Develop programs with conditionals, loops, functions and packages using Python for a given problem.
4. Apply suitable data structure in Python for a real world problem.
5. Create and manipulate files using Python.

LIST OF EXPERIMENTS

1. Study of basic commands in Linux OS.
2. Creating document, presentation slides and performing mathematical calculations using Libre Office packages.
3. Solving problems using algorithm and flowchart.
4. Python statements to check variable validity, data types and expression evaluation.
5. Programs to implement decision control statements.
6. Programs to implement functions.
7. Programs to implement modules and packages.
8. Programs for string handling functions.
9. Programs to implement list, set, tuple and dictionary.
10. Programs for file handling.

SOFTWARE

- Python 3 interpreter for Linux environment
- Jupyter Notebook IDE
- Raptor Tool
- Libre Office Packages

TOTAL: 45 PERIODS

21MEL22	COMPUTER AIDED DRAFTING AND MODELING LABORATORY	L T P C
		0 0 3 1

Preamble:

Computer Aided Drafting and Modeling Laboratory course provides the students with the knowledge on the use of software and its various features and tools for drafting and modeling the Engineering components with different geometries and morphological features, dimensioning, mentioning tolerances and for creating architectural drawings. This course includes drafting orthographic views of Engineering curves, simple solids and sectioned solids, 3D models of simple mechanical or electrical devices and drawing residential plans.

Course Outcomes: Upon completion of the course, students will be able to:

1. Develop the 2D sketches for the given conditions using drafting packages.
2. Sketch the orthographic views for the given isometric view of solids.
3. Create 3D models of simple engineering components.
4. Develop multiple views from the solid modeled.
5. Draw the plan and elevation of residential buildings.

LIST OF EXERCISES USING DRAFTING SOFTWARE (AUTOCAD OR EQUIVALENT)

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative and polar) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing a Title Block with necessary text and projection symbol.
3. Drawing curves – Ellipse, parabola, spiral, involute using B-spline or cubic spline.
4. Drawing front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views.
6. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model. (Eg. V-block, Base of a mixer, Simple stool, Objects with hole and curves).
7. Drawing isometric projection of simple objects.
8. Drawing a simple steel truss.
9. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
10. Drawing a plan of residential building (Two bed rooms, kitchen, hall, etc.)

TOTAL : 45 PERIODS

REFERENCES:

1. Gowri, S. and Jeyapoovan, T., “Computer Aided Drafting and Modeling Laboratory”, Vikas Publishing House Pvt., Ltd., 1st Edition, 2011.
2. Manual prepared by the faculty of Mechanical Engineering Department, VCET.

e-RESOURCES:

1. http://www.pearsonhighered.com/educator/course/AutoCAD-ComputerAided-Drawing/91024782.page

21MCT02 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
2 0 0 0

Preamble:

The study of biodiversity reflects the extent of the interest of a nation in its natural resources and heritage, which is considered as a crucial portion of the national wealth. Since India is one of the twelve mega-diversity center of the earth, much emphasis should be put on understanding, preserving and utilizing the biodiversity of our biotic resources. Environmental protection is an important issue for society today as scientific research provides evidence of increasing global warming, ozone depletion and higher levels of pollution. Engineers should learn how to design, develop and evaluate structures, equipment and systems to provide practical solutions to problems caused by pollution, exploitation of natural resources and population explosion.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compare and contrast structure and function of forest and marine ecosystem to conserve biodiversity
2. Analyze the sources, effects, control measures of air and water, solid waste management to maintain green environment.
3. Describe overexploitation of forest, overutilization of water and environmental impacts related to food resources to preserve environment.
4. Explain human health, environment and disaster management through information technology.
5. Discuss air and water act to solve environmental issues of climatic change.

UNIT 1 ECOSYSTEM AND BIODIVERSITY MANAGEMENT 6

Importance of environmental studies-Ecosystem-Definition, Characteristics, structure and functions of Forest and Ocean ecosystem.Biodiversity-Definition, Significance, Values of biodiversity, Threats to biodiversity-Habitat loss and poaching, Biodiversity conservation-In-situ (Biosphere and National park), Ex-situ (Gene bank and Seed bank)

UNIT 2 ENVIRONMENTAL POLLUTION 6

Pollution- Definition causes and effects of Air and Water. Control strategies-Air pollution- (Catalytic converter, Cyclone separator). Water pollution-waste water treatment (Primary, Secondary and Tertiary Treatment). Solid waste-Source and generation of solid waste, Methods of disposal- Sanitary land fill, Incineration and composting.

UNIT 3 NATURAL RESOURCES 6

Forest Resources: Functions of forest, deforestation-causes, consequences and steps to prevent deforestation. Water Resources: over-exploitation of surface and ground water, Benefits and problems of dams on forests and tribal people. Food Resources: Environmental impacts related to food resources –Effects of modern agriculture (fertilizer and pesticide problems),water logging and salinity.

UNIT 4 ROLE OF IT AND DISASTER MANAGEMENT 6

Role of IT in environment-Remote Sensing and GIS application,Global positioning system, Environmental data base. Role of IT in human health – EHR, Medical Transcription, Endoscopy, Automated dispensing machine (ADM), Teleconference, Picture achieving and Communication System (PACS) method.Disaster management-Cause, effects and mitigation of Flood, Cyclone, Earthquake, Tsunami

UNIT 5 SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION 6

Social Issues: Climate change- Global warming, Ozone layer depletion, Water conservation-Rain water harvesting (Roof top method). Legislation- Function of State and Central pollution control Board (Air and Water).

TOTAL:30PERIODS

TEXT BOOKS:

1. Dr.Arun Luiz T, 'Environmental Science and Engineering', 1st edition (2017), VK publications.
2. P. Yugananth&Dr. R. Kumaravelan,'Environmental Science and Engineering', 2ndedition, reprint (2017),Scitech Publication (India) Pvt. Ltd., Chennai.

REFERENCES:

1. Benny Joseph, 'Environmental Science and Engineering', 3rdreprint (2015), McGraw Hill Education (India) PvtLtd.,New Delhi.
2. Gilbert M.Masters, 'Introduction to 'Environmental Engineering and Science', 2nd edition (2004), Prentice Hall of IndiaPvt. Ltd.

e-RESOURCES:

1. https://nptel.ac.in/courses/105104099/4" Types and forms of Air Pollutants" – Prof. Mukesh Sharma,Department of Civil Engineering, IIT Kanpur.
2. https://nptel.ac.in/courses/105104183/8-"Introduction to natural hazards(Flood and Tsunami)- Prof.Javed Malik, Department of Civil Engineering,IIT Kanpur

21MAT31 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C

(Common to B.E./B.Tech. BME, ECE, EEE, IT, CE, ME, MDE programmes in Third Semester) **3 1 0 4**

Preamble:

The phenomena of heat conduction, wave and signal propagation in media are described by Partial Differential equations (PDE) or Difference equations. For analyzing such phenomena, knowledge of mathematical techniques for solving PDE and Difference equations are needed for engineering students. This course aims to provide sufficient knowledge to engineering students in the specific mathematical techniques such as Fourier series, Fourier transform, Z-transform and PDE.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compute the trigonometric form of the Fourier series for periodic waveforms satisfying the Dirichlet's conditions and using them to evaluate infinite series.
2. Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and second order with constant coefficients.
3. Compute the analytical solution for the given physical model for the specified initial and boundary conditions in one dimensional and two dimensional distributions.
4. Compute the Fourier transform of elementary non-periodic waveforms using Fourier Transform properties.
5. Solve the difference equations of first and second order using Z-transform techniques.

UNIT 1 FOURIER SERIES **9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

UNIT 2 PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation of partial differential equations – Singular Integrals – Solutions of standard types of first order partial differential equations: $F(p,q) = 0, F(z,p,q) = 0, F(x,p) = G(y,q)$ and $z = px + qy + F(p,q)$ – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of homogeneous type.

UNIT 3 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9+3**

One dimensional wave equation – Transverse vibrations of a string – One dimensional equation of heat conduction – Steady state temperature distribution in a rod – Two dimensional steady state temperature distributions in a plate.

UNIT 4 FOURIER TRANSFORMS **9+3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

UNIT 5 Z TRANSFORMS AND DIFFERENCE EQUATIONS **9+3**

Z-transforms - Elementary properties – Inverse Z-transform (using Partial Fraction and Residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).
2. Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016)

REFERENCES:

1. Ramana.B.V., "Higher Engineering Mathematics", First edition, Tata Mc-GrawHill Publishing Company limited, New Delhi, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Tenth edition, Wiley Dream Tech India (P) Ltd. 2016
3. Babu Ram, "Engineering Mathematics", Second edition, Vol.2 , Dorling Kindersley India (P) Ltd, Licenses of Pearson Education in South Asia, 2012

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/27 , "Advanced Engineering Mathematics", Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof.R.Radha, and Prof S. Thangavelu, Department of Mathematics, Indian Institute of Technology Madras, Chennai

21MET31 FLUID MECHANICS AND MACHINERY L T P C

3 0 0 3

Preamble:

Fluid Mechanics and Machinery deals with the fluids flow through pipes, turbines and pumps. This course is mainly concerned about the study of characteristics of fluids, dynamics of fluid flow, model analysis and fluid machineries used in Engineering industry. This course is subdivided into Fluid mechanics and Machinery. Fluid mechanics deals with the study of fluid properties considering friction and minor losses while Fluid Machinery deals about power and efficiency calculations in the hydraulic turbines and pumps.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the dynamics of fluid flow and summarize the flow characteristics.
2. Identify the flow characteristics and solve the problems caused in flow through pipes.
3. Apply the principles of dimensional analysis and model analysis to fluid flow related problems.
4. Analyze critically the performance of turbines.
5. Apply the energy exchange process in pumps.

UNIT 1 FLUID CHARACTERISTICS AND DYNAMICS OF FLUID FLOW 9

Introduction to fluid properties – Density, specific weight, specific volume, specific gravity, viscosity, compressibility, surface tension and capillarity. Flow characteristics –Rate of flow, concept of control volume and continuity equation for one dimensional flow.

Dynamics of fluid flow – Euler's equation of motion, Bernoulli's equation and Practical application of Bernoulli's equation – Venturimeter and Orifice meter – Horizontal type.

UNIT 2 FLUID FLOW TYPES AND FLOW THROUGH PIPES 9

Flow of viscous fluid through circular pipe–Hagen-Poiseuille equation. Types of fluid flow – Steady and unsteady, Uniform and non-uniform, Laminar & Turbulent, Compressible & incompressible, Rotational and irrotational (Qualitative treatment).

Flow through pipes (Loss of energy in pipes) – Major losses – Darcy-Weisbach equation and Chezy's formula – Minor losses, Moody diagram (Qualitative treatment). Flow through pipes in series and parallel.

UNIT 3 DIMENSIONAL AND MODEL ANALYSIS 9

Introduction, Derived quantities, Dimensional homogeneity – Methods of dimensional analysis – Buckingham's π-Theorem.

Model analysis – Similitude – Dimensionless numbers – Reynold's, Froude's, Euler's, Weber's, Mach's numbers. Model laws –Reynold's, Froude's, Euler's, Weber's, Mach's Model laws (Qualitative treatment).

UNIT 4 HYDRAULIC TURBINES 9

Classification of turbines, Constructional details, Head and efficiencies of turbines, Velocity triangles, Power and efficiency calculations of Pelton wheel, Inward and outward radial flow Reaction turbines, Francis turbine and Kaplan turbine. Performance characteristics of turbines (Description only).

UNIT 5 PUMPS 9

Centrifugal pumps - Constructional details, Working principle, Velocity triangle, Work done by the impeller, Head and efficiencies. Multi stage centrifugal pump for high head and high discharge. Specific speed and model testing of centrifugal pump.

Reciprocating pump - Constructional details, Working principle, Slip, Discharge, Work done, Power required to drive single acting and double acting pumps. Rotary pumps –Classification-Working principles. Special type pumps, House hold application pumps.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Bansal. R.K, "Fluid Mechanics and Hydraulic Machines", 9th Revised Edition, Laxmi Publications, 2014.
2. Rajput. R.K, "A Textbook of Fluid Mechanics and Hydraulic Machines", 1stEdition, S.Chand Publishing, 2015.

REFERENCES:

1. Kumar. K.L, "Engineering Fluid Mechanics",S.Chand Publishing, 2013.
2. Dr. Modi.P.N and Seth.S.M, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2017.
3. Victor L Streeter,E. Benjamin Wylie, K.W. Bedford, "Fluid Mechanics", 9th Edition, McGraw Hill Education India, Noida, 2014.

e-RESOURCES:

1. http://www.nptelvideos.in/2012/11/fluid-mechanics.html
   Prof. Eldho. T.I, IIT Bombay, Fluid Mechanics.
2. http://ocw.uci.edu/lectures/engineering_mae_130a_lecture_01_intro_to_fluid_mechanics.html

21EEC31 ELECTRICAL DRIVES AND CONTROL L T P C
3 0 2 4

Preamble:
To enable the students to gain a fair knowledge on characteristics and applications of electrical drives and how to control the speed of the AC & DC Motor drives.

Course Outcomes: Upon completion of the course, students will be able to:
1. Identify and explain the types and selection of rating of electrical drives.
2. Analyze the speed-torque characteristics and braking characteristics of electrical drives for DC shunt, series and induction motors.
3. Illustrate the types and characteristics of DC and AC motor starters.
4. Compare and contrast the conventional and solid-state speed control of DC and AC drives.
5. Experiment and test the speed control of DC and AC motors and the performance analysis of DC and AC motor drives.

UNIT 1 ELECTRICAL DRIVES 9
Basic Elements – Types of electrical drives – Factors influencing the choice of electrical drives – Heating and Cooling curves – Classes of duty – Selection of Power rating for Motor drives.

UNIT 2 DRIVE MOTOR CHARACTERISTICS 9
DC Shunt motor, DC Series motor and Induction motors, Speed-Torque characteristics and braking characteristics of DC shunt, Series and Induction motors.

UNIT 3 DC AND AC MOTOR STARTERS 9
Need for starters-Types of DC Motor starters: Two Point Starter, Three Point Starter and Four Point Starter – Types of AC Motor starters: Direct on-line Starter, Primary Resistance Starter, Auto-transformer Starter, Star-Delta Starter and Rotor Resistance Starter.

UNIT 4 CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF DC DRIVES 9
Speed control of DC series and shunt motors: Armature control, field control, Ward-Leonard control – Phase controlled converters and Four Quadrant Chopper – Applications.

UNIT 5 CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF AC DRIVES 9
Speed Control of Induction Motors: Stator side control, rotor side control – Slip power recovery schemes: Static Kramer drive – Static Scherbius drive – Applications.

PRACTICAL COMPONENTS:
1. Starting methods of DC and AC motors.
2. Speed control of DC and AC motors.
3. Performance analysis of DC motors with variable load.
4. Performance analysis of AC motors with variable load.

TOTAL: (L:45+P:15): 60 PERIODS

TEXT BOOKS:

1. Vedam Subrahmanyam, “Electric Drives: Concepts and applications”, Tata McGraw-Hill, 2015
2. Nagrath I.J. and Kothari D.P, “Electrical Machines”, Tata McGraw-Hill, 2016

REFERENCES:

1. Pillai. S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 1998
2. Singh. M.D., K.B. Khanchandani, “Power Electronics”, Tata McGraw-Hill, 1998
3. Pratab. H., “Art and Science and Utilization of Electrical Energy”, Dhanpat Rai and Sons,1994

e. RESOURCES:
1. http://www.nptelvideos.in/2012/11/advanced-electric-drives.html, Advanced Electrical Drives, Advanced Electric Drives, NPTEL Videos, IIT Delhi.

21MET32 ENGINEERING THERMODYNAMICS L T P C
3 1 0 4

Preamble:

Thermodynamics is a branch of science that deals with energy and its transfer. All activities in nature involve some interaction between energy and matter. Engineering thermodynamics plays a major part in the design and analysis of automotive engines, rockets, jet engines, refrigeration and air-conditioning systems, and power plants, etc. Therefore, developing a good understanding of the basic principles of engineering thermodynamics is essential for mechanical engineers. This course deals with the basic principles and concepts of thermodynamics, laws of thermodynamics, energy and entropy of ideal gas, steam, and mixture of gases.

Course Outcomes: Upon completion of the course, students will be able to:

1. Determine the energy transfer and change in properties of ideal gas or steam in thermodynamically open systems during different thermodynamic processes.
2. Apply the second law of thermodynamics and to calculate the efficiency of thermal equipment.
3. Identify the properties of pure substances and explain the working of steam power cycles.
4. Comprehend the thermodynamic relations, ideal and real gas behaviors.
5. Analyze the different psychrometric processes and their applications.

UNIT 1 THERMODYNAMIC SYSTEMS AND FIRST LAW 12

Basic concepts - Concept of continuum, Macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics - Concept of temperature and heat.

First law of thermodynamics - Application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipment.

UNIT 2 SECOND LAW OF THERMODYNAMICS 12

Second law of thermodynamics - Kelvin's and Clausius statements of second law. Reversibility and irreversibility. Carnot theorem, Carnot cycle, reversed Carnot cycle, efficiency, COP.

Thermodynamic temperature scale, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy – Exergy analysis.

UNIT 3 PROPERTIES OF PURE SUBSTANCES AND STEAM POWER CYCLE 12

Properties of pure substances - Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes.

Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles.

UNIT 4 IDEAL, REAL GASES AND THERMODYNAMIC RELATIONS 12

Gas mixtures – Properties of ideal and real gases, equations of state, Avagadro's Law, Vander Waal's equation, compressibility factor, compressibility chart - Dalton's law of partial pressure, exact differentials.

Tds relations, Maxwell's relations, Clausius Clapeyron equations, Joule –Thomson coefficient. (Qualitative treatment only).

UNIT 5 PSYCHROMETRY 12

Psychrometry and Psychrometric charts, property calculations of air vapour mixtures by using chart and expressions.Psychrometric processes - Sensible heating and cooling, humidification, dehumidification. Adiabatic mixing and evaporative cooling. Simple Applications: Air-conditioning, Refrigeration.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. P K Nag, "Engineering Thermodynamics", 5th Edition, McGraw-Hill Education (India) Private Limited, 2014.
2. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, New Delhi : PHI Learning, 2015.

REFERENCES:

1. Cengel. Y and M.Boles, "Thermodynamics - An Engineering Approach", 8th Edition, McGraw Hill Education (India), 2017.
2. R.K. Rajput, "A Textbook of Engineering Thermodynamics", Fifth Edition, Lakshmi Publications Pvt. Ltd., New Delhi, 2017.
3. Natarajan E, "Engineering Thermodynamics", 2nd Edition, Anuragam Publications, 2014.

e-RESOURCES:

1. http://nptel.ac.in/courses/112105123/Prof. S. K. Som/ Basic Thermodynamics/Indian Institute of Technology, Kharagpur.
2. http://www.nptelvideos.in/2012/12/basic-thermodynamics.html//Prof.S.K.Som/Basic Thermodynamics /Indian Institute of Technology, Kharagpur.

21MET33 MANUFACTURING TECHNOLOGY L T P C

3 0 0 3

Preamble:

Manufacturing technology deals with the metal casting, metal joining, forming and machining processes. This course is mainly concerned with the basic mechanics of metal cutting, working of standard machine tools such as lathe, shaper, drilling, milling and grinding machines. Theory of metal cutting deals with the mechanics of chip formation, tool signature, tool wear, tool life and also cutting tool materials.

Course Outcomes: Upon completion of the course, students will be able to:

1. List the various metal casting processes and explain the purpose of sand, pattern and core in the cast mould.
2. Describe the appropriate metal joining and forming process based on the functional requirements and their applications.
3. Discuss the mechanism of chip formation in machining.
4. Describe the constructional and operational features of centre lathe and special purpose lathes.
5. Explain the various machining processes such as shaping, milling, hobbing and grinding.

UNIT 1 METAL CASTING PROCESSES 9

Sand casting – Types of patterns – Pattern materials – Pattern allowances – Types of Moulding sand – Properties –Core and types of core– Moulding machines – Types of Moulding. Melting furnaces: Cupola furnace, electric arc furnace and induction furnace. Working principle of Special casting processes: Shell casting – Ceramic mould – Lost Wax process – Centrifugal casting – CO_2 process. Sand Casting defects.

UNIT 2 METAL JOINING AND FORMING PROCESSES 9

Gas welding - Types – Flame characteristics - Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding –Operating principle and applications of Resistance welding and Plasma arc welding –Weld defects: types, causes and cure. Basics of Brazing and soldering.

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging. Rolling of metals – Types of Rolling mills: Shape rolling operations. Principles of Extrusion – Hot and Cold extrusion.

UNIT 3 THEORY OF METAL CUTTING 9

Mechanics of chip formation, single point cutting tool – Orthogonal and Oblique cutting – Types of chip – Forces in machining – Merchant's circle Diagram – Cutting tool: Nomenclature, Cutting tool materials, Thermal aspects, tool wear, tool life – Cutting fluids and Machinability.

UNIT 4 CENTRE LATHE, AUTOMATS AND DRILLING 9

Centre lathe: Constructional features, various operations – Taper turning methods – Thread cutting methods –Machining time and power estimation. Capstan and Turret lathes – Turret Indexing mechanism and Tool layout. Automats: single spindle, swiss type, multi spindle, automatic screw type – Introduction to drilling machines.

UNIT 5 MACHINE TOOLS AND ABRASIVE PROCESS 9

Shaper: Classification, specifications, operations and work holding devices – Quick return mechanism. Milling Machine: Column and Knee type milling machine, specifications & operations performed – Milling cutters, Nomenclature of plain milling cutter, Work holding devices – Gear hobbing and Gear shaping machines. Abrasive processes: Grinding wheel – Specifications and selection, Types of grinding process– Cylindrical grinding, Surface grinding, Centreless grinding and Internal grinding.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology, Vol. I&II", 15th Edition, Media Promotors & publishers Pvt Ltd., Mumbai, 2013.
2. P.C. Sharma, "A text book of Production Technology (Manufacturing Processes)",8th Edition, S. Chand and Company, 2015.
3. Rao. P.N "Manufacturing Technology,Vol. I",4th Edition, McGraw Hill Education, New Delhi, 2013.

REFERENCES:

1. Serope Kalpakjain and Steven R.Schimd, “Manufacturing Process for Engineering Materials”, 14th Edition, Pearson Education,2013.
2. Rajput R.K, “A text book of Manufacturing Technology”, 5th Edition Lakshmi Publications, 2017.
3. Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools",11th Edition, McGraw Hill Education, New Delhi, 2017.

e-RESOURCES:

1. http://nptel.ac.in/courses/112107145/Prof. Inderdeep Singh et al., IIT Roorkee, Manufacturing Processes -1
2. http://nptel.ac.in/courses/112102103/1 Prof.Madhusudan Rao, IIT Delhi, Machining Processes.

21MEL31 MANUFACTURING TECHNOLOGY LABORATORY L T P C

0 0 3 1

Preamble:

Manufacturing Technology Laboratory provides the students with the knowledge on making of moulds using various patterns. This course deals with the processes such as gas welding and gas cutting operations. It also provides the students with the knowledge of performing various operations in lathe such as step turning, taper turning, threading, eccentric turning, grooving, drilling, boring and knurling and also multiple operations in capstan/turret lathe.

Course Outcomes: Upon completion of the course, students will be able to:

1. Prepare sand moulds for various patterns.
2. Fabricate components using gas and spot welding processes
3. Perform turning, external thread cutting, taper boring and knurling operations using lathe.
4. Conduct drilling, boring and internal/external thread cutting operations using lathe.
5. Perform multiple operations using capstan/turret lathe.

LIST OF EXPERIMENTS

1. Preparation of green sand mould with single piece and multi piece patterns
2. Gas welding and gas cutting
3. Spot Welding with different thickness plates by selecting appropriate current settings
4. Performing Step Turning, knurling and chamfering operations
5. Taper turning using compound rest / attachment method
6. Eccentric Turning
7. Performing Taper boring
8. External thread cutting, grooving and knurling
9. Drilling, boring and internal thread cutting
10. Multiple operations using capstan / turret lathe
11. Introduction to machining cost calculations

TOTAL : 45 PERIODS

21MEL32	FLUID MECHANICS AND MACHINERY LABORATORY	L T P C
	(For the students admitted in 2020-21onwards)	0 0 3 1

Preamble:

Fluid Mechanics and Machinery Laboratory course provides the students with the knowledge on the use of fluid principles and its equipment for measuring and calculating the flow parameters with different flow rates and for determining coefficient of discharge. This course includes calculating efficiencies, power output in various pumps and turbines for creating performance characteristic curves.

Course Outcomes: Upon completion of the course, students will be able to:

1. Calibrate flow measuring devices such as venturimeter, orifice meter, etc.
2. Operate fluid flow equipment and instruments.
3. Analyze the various losses during flow through pipes.
4. Experiment and analyze the performance of impulse and reaction turbines.
5. Conduct performance analysis of rotary and reciprocating pumps.

LIST OF EXPERIMENTS

1. Determination of the coefficient of discharge of given Orifice meter and Venturimeter.
2. (i) Calculation of the rate of flow using Rota meter.
   (ii) Determination of friction factor for a given set of pipes.
3. Minor losses due to pipe fittings in pipes.
4. Verification of Bernoulli's Theorem.
5. Performance analysis of Pelton wheel.
6. Performance analysis of Kaplan turbine.
7. Performance analysis of Francis turbine.
8. Performance analysis of Centrifugal pump.
9. Performance analysis of Reciprocating pump.
10. Performance analysis of Gear pump.

TOTAL : 45 PERIODS

21MCL03	ESSENTIAL ENGLISH FOR PROFESSIONALS (Common to all Branches in Third Semester)	L T P C 0 0 2 0

Preamble :

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Essential English for Professionals aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

Course outcomes : After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly employing listening techniques.
2. Analyze the given reading material and answer the questions correctly employing reading techniques.
3. Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of paragraphs and letters.
4. Give well structured effective time sensitive presentations extemporaneously or after careful preparation.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

UNIT 1 LISTENING **6**

Listening to Casual Conversation and TED Talks

UNIT 2 READING **8**

Poem – Robert Frost – Road not Taken Essays - Bacon's Essays

UNIT 3 WRITING **6**

Letter Writing – Letters Seeking Permission and Letters Seeking Apology and Letters Requesting Certificates and Paragraph Writing

UNIT 4 PRESENTATION **7**

Watching Presentations - Presentation Techniques - JAM and Three Minute Presentation

UNIT 5 VERBAL ABILITY **3**

Verbal Analogy - Cloze Test- Idioms and Phrases- Sentence Completion – Concord – Common Errors

TOTAL : 30 PERIODS

REFERENCES:

1. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2021.
2. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.

e-RESOURCES:

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. https://www.naukri.com/blog/self-introduction-for-interview/
4. http://learnenglishteens.britishcouncil.org/skills/reading
5. https://www.bbc.com/bitesize/guides/zphc9j6/revision/1

21MAT44 **STATISTICS AND NUMERICAL METHODS** **L T P C**

(B.E. MECHANICAL Programme in Fourth Semester) **3 0 0 3**

Preamble:

Statistics is a branch of science that can be applied practically in every walk of life. This course aims at giving adequate exposure to testing of hypothesis and design of experiments. Also it provides computational methods for getting numerical solution for algebraic, transcendental equations and initial value problems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Test the statistical hypothesis for mean and variance using z test, t test, F test and chisquare test.
2. Analyse variance in a designed statistical experiment by one way and two way classification.
3. Solve the algebraic and transcendental equations by Newton Raphson method and simultaneous equations by direct and Indirect methods.
4. Calculate interpolation , Differentiation of data by Newton's method and integration of a function by Trapezoidal and Simpson's rule
5. Solve the ordinary differential equations using Taylor's series, Euler's method and Runge Kutta method.

UNIT 1 TESTING OF HYPOTHESIS **9**

Large sample test based on Normal distribution for single mean and difference of means – Small sample tests based on t distributions for testing of means and F distributions for testing of variances – χ^2 test – Contingency table (Test for Independency) – Goodness of fit.

UNIT 2 DESIGN OF EXPERIMENTS **9**

One way and two way classifications - Completely randomized design – Randomized block design –Latin square design.

UNIT 3 SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS **9**

Algebraic and Transcendental equations-Newton Raphson method – System of Simultaneous equations – Gauss elimination method – pivoting – Gauss Jordan methods – Iterative methods of Gauss Jacobi and Gauss Seidel — Eigenvalues of a matrix by power method.

UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION **9**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of first derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT 5 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9**

Taylor's series method – Euler's method — Fourth order Runge-Kutta method for solving first order equations – Milne's predictor corrector methods for solving first order equations – Finite difference methods for solving second order equations.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Johnson. R.A., and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers",8th Edition, Pearson Education India, 2015.
2. Grewal. B.S., "Numerical Methods in Engineering and Science", 10th Edition, Khanna Publishers, New Delhi, 2014.

REFERENCES:

1. Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education India , 2013.
2. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGraw Hill Education India Private Limited,2016.
3. Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" 7th Edition, Pearson Education India, 2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/111104075/13, "Analysis of Variance and Design of Experiments,Module-III, Dr. Shalabh, Department of Mathematics and Statistics ,Indian Institute of Technology ,Kanpur.
2. http://nptel.ac.in/courses/111105041/40 , "Probability and Statistics", Prof. Dr. Somesh Kumar , Department of Mathematics Indian Institute of Technology, Kharagpur.

21MET41 **DESIGN ENGINEERING** **L T P C**

3 0 0 3

Preamble:

This course provides an introduction to the basic concepts and techniques of design and product development process, problem identification and problem-solving techniques, material selection and design approach to increase the overall human health and environmental impact of a product. There were many new techniques developed over a period of time. There is a need to discuss a unified approach of design in a course.

Course Outcomes: Upon completion of the course, students will be able to:

1. Apply the knowledge on various design process and methods for product design.
2. Implement the various integrated process and product development involved in various organizations.
3. Identify the customer needs by various tools and introduce the creative thinking in new product development.
4. Implement the various manufacturing process with design of materials for various applications.
5. Describe the material selection, human factors and environment design to achieve eco-friendly product design.

UNIT 1 ENGINEERING DESIGN PROCESS **9**

Importance of the Engineering Design Process, Types of Designs - Problem-Solving Methodology – Phases in Design Process - Considerations of a Good Design - Design Review – Dimensions and Tolerances (Qualitative Treatment Only).

UNIT 2 PRODUCT DEVELOPMENT PROCESS **9**

Product Development Process – Phases, Factors for Success - Product and Process Cycles - Stages of Development of a Product, Process Development Cycle - Organization for Design and Product Development - A Typical Functional Organization, Organization by Projects, Hybrid Organizations - Technological Innovation - Invention, Innovation, and Diffusion, Types of Technology Innovation

UNIT 3 PROBLEM SOLVING TOOLS AND CONCEPTUAL DESIGN **9**

Problem Solving Tools – Brainstorming, How-How Diagram and Why-Why Analysis – Tools for Design Optimization - Taguchi Method, Analytic Hierarchy Process (AHP) - Introduction to Creative Thinking - Creativity and Problem Solving – Supports and Barriers to Creative Thinking - Creative Thinking Methods - Random Input Technique, Concept Map - Systematic Methods for Designing – TRIZ.

UNIT 4 MATERIAL PROCESSING AND DESIGN **9**

Classification of manufacturing processes and their role in design - Factors determining the process selection – Guidelines - Design for manufacturing, Design for casting, Design for forging, Design for sheet metal forming, Design for machining – Introduction to Embodiment Design and Product Architecture.

UNIT 5 HUMAN FACTORS DESIGN AND DESIGN FOR ENVIRONMENT **9**

Relation of Materials Selection to Design - Performance Characteristics of Materials - The Materials Selection Process - Design for Reliability and Safety - Ergonomics - Human Physical Effort - Sensory Input - Anthropometric Data - Design for Serviceability - Design for the Environment – Life Cycle Design - Rapid Prototyping, RP Process.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. George E. Dieter and Linda C. Schmidt, "Engineering Design", Fourth Edition, McGraw-Hill, International Edition, 2009.
2. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", Sixth Edition, McGraw-Hill, International Edition, 2016.

REFERENCES:

1. Krishnan S. and & Shukla M., "Concepts in Engineering Design", First Edition, Notion press, Chennai, 2016.
2. Gerhard Pahl and Beitz W., "Engineering Design: A Systematic Approach", Third Edition, Springer - Verlag, NewYork, 2007.
3. Pradip N. Khandwalla, "Fourth Eye: Excellence Through Creativity", 2nd Edition, A.H.Wheeler Publishing Co. Ltd, 2000.

e-RESOURCES:

1. https://nptel.ac.in/courses/107108010/ Prof. Amaresh Chakrabarti, IISC Bangalore, Creative Engineering Design.
2. https://nptel.ac.in/courses/112104230/6 Dr.J.Ramkumar, IIT Kanpur, Product Design and Manufacturing.

21MEC42 **STRENGTH OF MATERIALS** **L T P C**
3 0 2 4

Preamble:

This course is concerned with the internal forces and associated changes in the geometry of the components involved. It also deals with the properties of the materials used, which will determine the failure of components in service and the amount of deformation caused in those components.

Course Outcomes: Upon completion of the course, students will be able to:

1. Calculate the stresses developed and deformation in bars.
2. Explain the bending and shear stress distribution in beams.
3. Identify and explain the torsional deformation in shafts and deflection in springs.
4. Discuss the Macaulay's method and computation of slope and deflection in beams.
5. Analyze the deformation in pressure vessels.
6. To perform tension test, impact test, torsion test, deflection test and hardness test on given specimens.

UNIT 1 STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Stresses– Types –Tension, Compression and Shear Stresses – Thermal stresses –Strain–Deformation of simple and compound bars – Poisson Ratio — Elastic constants – Volumetric strains.

Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress – Analytical and Graphical methods.

UNIT 2 TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types –Transverse loading on beams – Shear force and bending moment in beams –Cantilevers, Simply supported beams and over – hanging beams.

Theory of simple bending–bending stress distribution - Load carrying capacity – Proportioning of sections – Shear stress distribution.

UNIT 3 TORSION AND SPRINGS 9

Torsion –Formulation–Stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends.

Stresses in springs – Deflection of helical springs &carriage springs.

UNIT 4 DEFLECTION OF BEAMS 9

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method – Macaulay's method– Area moment method - Conjugate beam and strain energy method.

UNIT 5 THIN CYLINDERS, THICK CYLINDERSAND COLUMNS 9

Circumferential and longitudinal stresses and deformation in thin and thick cylindrical shells due to internal pressure.

Theory of columns - Long column and short column - Euler's formula - Rankine's formula.(Quantitative Treatment only).

UNIT 6 PRACTICAL COMPONENT 15

1. Tension test on steel rods in U.T.M.
2. Impact tests on metal specimen.
3. Torsion test on steel rod.
4. Deflection test on rectangular cross section beam (For point load and UDL).
5. Hardness tests on metals - Brinell and Rockwell Hardness.

TOTAL (L:45+P:15): 60 PERIODS

TEXT BOOKS:

1. Bansal R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2017.
2. Beer F. P. and Johnston R, "Mechanics of Materials", McGraw-Hill Education (India), New Delhi, Seventh Edition, 2017.

REFERENCES:

1. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2016.
2. R.k. Rajput., "Strength of Materials" [Mechanics of solids] ,S.Chand&Publications,2017.
3. Nash W.A, "Theory and problems in Strength of Materials", Schaum Outline Series, McGraw-Hill BookCo, NewYork, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/112107147/ Prof. Dr. SurajPrakashHarsha/ Strength-of-Materials /Indian Institute of Technology, Roorkee.
2. http://freevideolectures.com/Course/2361/ Prof. S.P.Harsha /Strength-of-Materials/Institute of Technology, Roorkee.

21MET43 THERMAL ENGINEERING L T P C
3 1 0 4

Preamble:
Thermal Engineering course deals with integrating the concepts, laws and methodologies from the first course in Thermodynamics into analysis of cyclic processes. This course also aims at applying the Thermodynamic concepts into various applications like IC engines, Steam turbines, Compressors and Refrigeration and Air conditioning.

Course Outcomes: Upon completion of the course, students will be able to:
1. Classify the various components of IC engines and discuss their functions.
2. Discuss the principles and to calculate the efficiency of various gas powered cycles.
3. Classify the turbines and draw the velocity diagrams of simple turbines.
4. Evaluate the performance of air compressors and to calculate their efficiencies.
5. Discuss the principle and working of refrigerators and air conditioners.

UNIT 1 INTERNAL COMBUSTION ENGINES 12

Classification - Components and their functions - Valve timing diagram and port timing diagram – Comparison between two stroke and four stroke engines - Comparison between Petrol and Diesel engines.

Simple Carburetor-Diesel pump and injector system-Battery and Magneto ignition system –Knocking-

UNIT 2 GAS POWER CYCLES 12

Otto, Diesel, Dual and Brayton cycles - Calculation of mean effective pressure and air standard efficiency - Comparison of cycles.

UNIT 3 STEAM NOZZLES AND TURBINES 12

Types and shapes of nozzles - Flow of steam through nozzles - Critical pressure ratio - Effect of friction - Metastable flow.

Impulse and Reaction turbine principles – Compounding - Velocity diagram for simple turbines – –Governors.

UNIT 4 AIR COMPRESSOR 12

Classification and working principles of various types of compressors-Work of compression with and without clearance-Volumetric efficiency - Isothermal efficiency and Isentropic efficiency-Multistage air compressor and intercooling –Work of multistage air compressor.

UNIT 5 REFRIGERATION AND AIR CONDITIONING 12

Refrigerants -Vapour compression refrigeration cycle and Performance calculation- Super heat and Sub cooling - Working principle of Vapour absorption system- Types: NH_3-H_2O and LiBr-H_2O systems (Description only).

Properties of atmospheric air – Psychrometric processes- Working principles of Summer, Winter, Split and Centralized AC systems - Simple cooling & heating load calculation.

TOTAL: 60 PERIODS

APPROVED DATA BOOKS: (Permitted for Semester Examination)
1. Khurmi.R.S, "Steam Table", 9th Edition, S.Chand Publishers, 2016.
2. Kothandaraman.C.P., "Refrigeration Tables and Charts", 3rd Edition, New Age International Pvt. Ltd., New Delhi, 2013.

TEXT BOOKS:
1. Rajput. R. K., "Thermal Engineering", 10th Edition, Lakshmi Publications, New Delhi, 2015.
2. Kothandaraman.C.P.,Domkundwar.S, Domkundwar. A.V.,"A Course in Thermal Engineering", 6th Edition, Dhanpat Rai & Co. Pvt. Ltd., 2012.

REFERENCES:
1. Ballaney P.L., "Thermal Engineering", 24th Edition, Khanna Publishers, New Delhi, 2014.
2. Ganesan V., "Internal Combustion Engines", 6th Edition, McGraw-Hill Education Pvt Ltd., New Delhi, 2014.
3. Arora.C.P, "Refrigeration and Air Conditioning", 3rd Edition, McGraw-Hill Education Pvt Ltd., New Delhi, 2015.
4. Sarkar, B.K, "Thermal Engineering", McGraw-Hill Education Pvt Ltd., New Delhi, 2014.

e-RESOURCES:

1. http://www.nptel.ac.in/courses/112105128/#, Prof. M. Ramgopal et al., Indian Institute of Technology, Kharagpur, Refrigeration and Air Conditioning.
2. https://www.coursera.org/learn/thermodynamics-intro/lecture/Ys3lv/03-02.

21MET44 **THEORY OF MACHINES** **L T P C**

3 1 0 4

Preamble:

Theory of machines is one of the core and traditional subjects in the Mechanical Engineering curriculum. It deals with the study of relative motion between various parts of a machine and forces which act on them. It emphasizes importance on kinematic analysis of mechanisms, cam profiles, gyroscopic effects, balancing, vibration, etc.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze various mechanisms for displacement, velocity and acceleration at any point in a moving link.
2. Design cam profile for the given follower motions.
3. Determine speed ratio of gear trains and analyze the effect of gyroscopic couple in automobiles, ships and air planes.
4. Solve force analysis problems in mechanical systems and explain balancing procedures of the basic balancing.
5. Estimate the natural frequency of single degrees of freedom system subjected to free and forced vibrations.

UNIT 1 MECHANISMS AND KINEMATIC ANALYSIS **12**

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom- Mobility – Kutzbach criterion - Gruebler's criterion – Grashof's law – Kinematic inversions of four-bar chain and slider crank chains and their applications.

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method: Relative velocity method– Analytical method. Coincident points– Coriolis component of Acceleration. A simple fabrication of any one simple mechanism (Not for Examination).

UNIT 2 CAM MECHANISMS **12**

Classification of cams and followers – Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – Velocity and acceleration diagrams – Layout of plate cam profiles – Pressure angle and undercutting.

UNIT 3 GEAR TRAINS AND GYROSCOPES **12**

Spur gear terminology and definitions -Law of toothed gearing— Gear trains – Speed ratio, Train value – Parallel axis gear trains – Epicyclic Gear Trains- Sun and planet wheel.

Gyroscopes – Gyroscopic forces and torques- Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in automobiles, ships and air planes.

UNIT 4 FORCE ANALYSIS AND BALANCING **12**

Static force analysis of mechanisms – Inertia force and Inertia torque – D'Alembert's principle - Dynamic force analysis - Dynamic Analysis in Reciprocating Engines – Crank shaft Torque - Turning moment diagrams - Flywheels of engines.

Static and dynamic balancing - Balancing of rotating masses - Balancing of single cylinder Engine – Partial balancing of locomotive engines –Tractive force, Swaying couple and Hammer blow.

UNIT 5 FREE AND FORCED VIBRATIONS **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 and critical speed - Torsional Vibrations, Natural frequency of two rotor systems.

Forced vibration with harmonic motion –Magnification factor – Forced vibration due to excitation of support- Vibration isolation – Transmissibility.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Rattan S.S, "Theory of Machines", 4th Edition, McGraw-Hill Education, 2015.
2. Khurmi, R.S, Gupta. J.K, "Theory of Machines", S.Chand & Company Pvt Ltd,2013

REFERENCES:

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
2. Robert L. Norton, "Kinematics and Dynamics of Machinery", McGraw-Hill Education, 2016.
3. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition, Affiliated East-West Pvt.Ltd., New Delhi, 2015.
4. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4th Edition, oxford University Press, 2017.

e-RESOURCES:

1. http://www.nptel.iitm.ac.in/video.php?subjectId=112104121
   Prof. A. K. Mallik, Indian Institute of Technology Kanpur, Kinematics of Machines
2. http://www.nptel.iitm.ac.in/video.php subjectId=112104114
   Prof.Amitabha Ghosh, Indian Institute of Technology Kanpur, Dynamics of Machines.

21MET45 ENGINEERING MATERIALS AND METALLURGY L T P C

3 0 0 3

Preamble:

This course is designed as a first introduction to microstructure and mechanical properties of engineering materials for undergraduate engineering students. The focus will be on clear presentation of basic fundamentals of structure and defects of crystalline materials. This will then be used to understand the transformations, heat treatments and mechanical behavior of structural materials.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain various reactions, microstructure and compositions in the phase diagrams.
2. Select appropriate heat treatment process for specific applications.
3. Identify and explain the composition, properties and applications of ferrous & non-ferrous metals.
4. Discuss the properties and applications of non-metallic materials.
5. Classify the various testing procedures to evaluate material properties.

UNIT 1 CONSTITUTION OF ALLOY AND PHASE DIAGRAM 9

Solid solutions – Substitutional and Interstitial, Hume Rothery's rule of solid solubility, Phase diagrams - Gibb's phase rule, Cooling curves for pure metals and binary alloys, Isomorphous system, Eutectic, Eutectoid, Peritectic and Peritectoid reactions.

Iron - Carbon system – Micro constituents, Iron - Iron Carbide equilibrium diagram, Slow cooling of eutectoid, hypoeutectoid and hypereutectoid steels.

UNIT 2 HEAT TREATMENT AND SURFACE HARDENING OF METALS 9

Heat Treatment: Types – Annealing - Full, Process, Stress relief, Recrystallization, Spheroidising– Normalizing – Hardening – Quenching, stages of quenching, hardening operation– Tempering – operation, classification, time temperature transformation diagram for Eutectoid steel and CCT Diagram**,** Critical Cooling Rate, Martempering and Austempering. Hardenability – Definition, Jominy End-Quench Test.

Surface Hardening: Diffusion methods – Carburizing, Nitriding, Cyaniding, Carbo nitriding – Thermal methods – flame and induction hardening, thermo mechanical treatments.

UNIT 3 FERROUS AND NON FERROUS METALS 9

Ferrous materials – Steels – Plain carbon and Alloy steels – Effect of alloying elements on steel – Mn, Si, Cr, Ni, Mo, Al, Cu – Stainless Steel, Tool Steel, HSLA Steels, Maraging Steels. Cast iron – Grey, White, Malleable and SG.

Non-ferrous materials – Copper and its alloys, Aluminium – Characteristics and strengthening treatment – Bearing materials – White, Copper Base and Aluminium base – Super Alloy.

UNIT 4 NON-METALLIC MATERIALS 9

Engineering Ceramics – Alumina, Silicon Carbide, Silicon Nitride, Partially Stabilized Zirconia and Sialons – Definition, Characteristics and Applications.

Composite materials – Definition, Constituents, Classification – Particle Reinforced, Fiber Reinforced, Metal Matrix, Polymer Matrix – Properties, Advantages, Limitations and Applications.

UNIT 5 MECHANICAL PROPERTIES AND TESTING OF MATERIALS 9

Mechanical properties, Deformation of metals – Plastic deformation mechanism – Slip and Twinning – Fracture – types and mechanisms.

Mechanical testing: Tensile, Compression and Shear tests, Hardness test – Brinell, Vickers, Rockwell, Impact test – Izod and Charpy – Fatigue test and Creep test.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sidney H Avner, "Introduction to Physical Metallurgy", 2nd Edition, McGraw Hill Education India, 2014.
2. Srinivasan. R, "Engineering Materials and Metallurgy", 4th Edition, Vijay Nicole imprints Pvt Ltd, 2021.

REFERENCES:

1. William D. Callister, David G. Rethwisch, "Materials Science and Engineering", 2nd Edition, Wiley India Pvt. Ltd., 2021.
2. Rajput. R.K, "Engineering Materials and Metallurgy", 1stEdition, S. Chand Publishing, New Delhi, 2011.
3. Raghavan. V, "Material Science and Engineering" 5th Edition, PHI Learning Pvt Ltd, New Delhi, 2013.

e-RESOURCES:

1. http://www.nptelvideos.in/2012/12/physics-of-materials.html
   Dr. Prathap Haridoss, IIT Madras, Physics of Materials.
2. https://www.mooc-list.com/course/mechanical-behavior-materials-part-3-time-dependent-behavior-and-failure-edx?static=true

21MEL41 **MACHINING PROCESSES LABORATORY** **L T P C**

0 0 3 1

Preamble:

Machining Processes Laboratory course provides the students with the knowledge of various basic machining operations in special purpose machines and their applications in real life manufacture of components in the industry. This course also imparts the knowledge on tool terminology, tool signatures, wear and tool life.

Course Outcomes: Upon completion of the course, students will be able to:

1. Perform keyway cutting operations using shaper and slotter machines.
2. Perform gear cutting operations using milling machine.
3. Conduct gear hobbing operation using hobbing machine.
4. Perform surface finishing operations using grinding machines.
5. Measure cutting forces in turning operations using dynamometer.

LIST OF EXPERIMENTS

1. Keyway cutting in shaper.
2. Keyway cutting in slotter.
3. Contour milling using vertical milling machine.
4. Spur gear cutting in milling machine.
5. Helical gear cutting in milling machine.
6. Gear generation in hobbing machine.
7. Plain surface grinding.
8. Cylindrical grinding.
9. Measurement of cutting forces in turning process.
10. Tool angle grinding with tool and cutter grinder.

TOTAL : 45 PERIODS

21MEL42	THERMAL ENGINEERING LABORATORY	L T P C
	(For the students admitted in 2020-21onwards)	0 0 3 1

Preamble:

Thermal Engineering Laboratory course provides the students with the knowledge on construction, working and performance evaluation of thermal systems such as IC engines, steam boiler, steam turbine, air compressor, refrigeration and air conditioning.

Course Outcomes: Upon completion of the course, students will be able to:

1. Experiment and determine fuel and lubricant properties.
2. Draw the valve and port timing diagrams for the IC engines.
3. Experiment and analyze the characteristics and performance of IC engine, compressor, steam boiler and turbine.
4. Experiment and analyze the heat loss in engine cylinder after the combustion and frictional loss in IC engine.
5. Experiment and determine the COP of refrigeration and air conditioning systems.

LIST OF EXPERIMENTS

1. Determination of flash point and fire point of various fuels / lubricants using open and closed cup apparatus.
2. Determination of viscosity using viscometers.
3. Performance test on reciprocating air compressor.
4. Valve timing and port timing diagrams.
5. Study of Dynamometers.
6. Performance test on 4 – stroke diesel engine.
7. Heat balance test on 4 – stroke diesel engine.
8. Morse test on multi-cylinder petrol engine.
9. Retardation test on a diesel engine.
10. Study of steam boilers and turbines.
11. Performance test on steam boiler and turbine.
12. Determination of COP of a refrigeration system.
13. Experiments on psychrometric process.

TOTAL : 45 PERIODS

21MCL04	PROFESSIONAL COMMUNICATION (Common to all Branches in Fourth Semester)	L T P C 0 0 2 0

Preamble:

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Professional Communication aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to situational LSRW tasks.

Course outcomes – After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly, employing listening techniques.
2. Take part effectively in group discussions, conforming to professional norms
3. Analyze the given reading material and answer the questions correctly, employing reading techniques
4. Write within the stipulated time, syntactically and semantically correct sentences to present ideas in the form of an essay.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises

UNIT 1 LISTENING **6**

Listening to News Bulletins and Documentaries

UNIT 2 GROUP DISCUSSION **8**

Watching Group Discussion videos – Do's and Don'ts of GD – Mock GD

UNIT 3 READING **6**

Letters to Editor Column - Reading News Articles - Biographies of Famous Personalities

UNIT 4 WRITING **6**

IELTS Essay Writing

UNIT 5 VERBAL ABILITY **4**

Verbal analogy - Cloze Test- Idioms and Phrases- Sentence Completion -Error Spotting

TOTAL : 30 PERIODS

REFERENCES:

1. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.
2. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2021

e-RESOURCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. https://www.bbc.com/bitesize/guides/zphc9j6/revision/1
3. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers

21MET51 **MACHINE DESIGN** **L T P C**
3 1 0 4

Preamble:

This course provides an introduction to the design procedure for various mechanical components. It introduces the concepts associated with stress and torque calculations of various machine elements such as fasteners, welded joints, shafts and couplings. Apart from this it also gives a detailed view of design of springs, design of flywheel and design of bearings.

Course Outcomes: Upon completion of the course, students will be able to:

1. Classify and explain the various steps involved in the design process, steady stresses and variable stresses in machine members.
2. Explain procedures involved in the design of shafts keys, splines and couplings.
3. Demonstrate the knowledge on the designs of threaded fasteners, Knuckle joints, Cotter joints, welded and riveted joints.
4. Design of flywheel, fasteners and different types spring for the specific applications.
5. Select appropriate rolling contact bearing, gasket and seal from the standard catalog based on loads.

UNIT 1 STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 12

Introduction to the design process - Factors influencing machine design, selection of materials based on mechanical properties – Preferred numbers, fits and tolerances – Direct, bending and torsional stress equations – Impact and shock loading – Eccentric loading.

Design of curved beams – Crane hook and 'C' frame - Factor of safety - Theories of failure – Stress concentration – Design for variable loading – Soderberg, Goodman relations.

UNIT 2 DESIGN OF SHAFTS AND COUPLINGS 12

Design of solid and hollow shafts based on strength and rigidity–Design of keys, keyways and splines.

Design of rigid coupling - Muff coupling - Flange coupling - Design of flexible couplings - Bushed pin type coupling.

UNIT 3 DESIGN OF TEMPORARY AND PERMANENT JOINTS 12

Threaded fasteners - Fine threads, Coarse threads - Design of bolted joints including eccentric loading - Design of Knuckle joints - Design of welded joints - Theory of bonded joints.

Design of Riveted Joints (Qualitative treatment only)

UNIT 4 DESIGN OF ENERGY STORING ELEMENTS 12

Design of various types of springs, helical springs, leaf springs - Design of flywheels considering stresses in rims and arms for engines and punching machines.

UNIT 5 DESIGN OF BEARINGS AND SEALS 12

Sliding contact and rolling contact bearings – Design of hydrodynamic journal bearings – Selection of rolling contact bearings- Theory of Lubrication.

Design of hydrostatic bearing – Design of seals and gaskets.

TOTAL : 60 PERIODS

DATA BOOKS:(allowed for reference during examinations also)

1. P.S.G. Tech., "Design Data" , Data book for Engineers, Kalaikathir Achchagam, Coimbatore, 2018.

TEXT BOOKS:

1. Bhandari V, "Design of Machine Elements", 3rd Edition, McGraw-Hill Eduactions, 2014.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett, "Mechanical Engineering Design", 8th Edition, McGraw-Hill Educations, 2014.

REFERENCES:

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", McGraw-Hill Educations (Schaum's Outline), 2010.
2. S.Md.Jalaludeen, "A Text book of Machine Design – I", Anuradha Publications, Chennai, 2014.
3. Sadhu singh, "Mechanical Machine Design", OBI Publishers, New Delhi,2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/112105124/
   Prof.B.Maitietal, IIT kharagpur, Design of Machine Elements
2. https://www.coursera.org/learn/machine-design1
   Dr. Kathryn Wingateetal., Woodruff School of Mechanical Engineering, Machine Design Part I

21MET52 **AUTOMOBILE ENGINEERING** **L T P C**
3 0 0 3

Preamble:

This course provides an introduction to vehicle structure, engine, power transmission system, steering system, brakes and suspension; it also provides an introduction to engine emissions and their control and offers basics electric vehicles and automotive electronics system.

Course Outcomes: Upon completion of the course, students will be able to:

1. Classify vehicles and identify each component and their functions in the automobile.
2. Explain the function of fuel injectors and awareness of emissions through various norms.
3. Discuss about torque transmission to wheels through types of gear boxes and its associated components.
4. Differentiate steering gear boxes and know the latest developments in braking system.
5. Illustrate about automotive electronics system for engine, chassis & Occupant-protection systems.

UNIT 1 VEHICLE STRUCTURE AND ENGINES **9**

Types of automobiles - Vehicle construction and different layouts - Chassis, frame and body. Vehicle aerodynamics (various resistances and moments involved) - IC engines – Components, functions and materials – Introduction to Electric Vehicles – Energy Sources Battery-Lead acid battery, Li-ion Battery - Construction, Cell Discharge & Cell Charge Operation - Introduction to Hybrid Vehicles - Hydrogen Fuel cell.

UNIT 2 ENGINE AUXILIARY SYSTEMS **9**

Electronically controlled gasoline injection system for SI engines - Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system).

Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system) - Super charging and Turbo charging - Engine emission control by three way catalytic converter system - Emission norms (Euro and BS).

UNIT 3 TRANSMISSION SYSTEMS **9**

Clutch: Need – Dry and wet type – Single plate clutch – Diaphragm clutch –Fluid coupling. Gear boxes- Manual and automatic (hydramatic transmission system) - Gear shift mechanisms - Over drive, Transfer box.

Fluid flywheel - Torque converter, Propeller shaft, Slip joints, Universal joints, Differential and Rear axle, Hotchkiss drive and Torque tube drive.

UNIT 4 STEERING, BRAKES AND SUSPENSION SYSTEMS **9**

Steering geometry and types of steering gear box- Power Steering - Types of Front Axle - Types of Suspension systems.

Pneumatic and hydraulic braking systems - Antilock Braking System (ABS) - Electronic brake force distribution (EBD) and Traction control - Electronic stability control.

UNIT 5 AUTOMOBILE ELECTRONICS **9**

Current trends in modern automobiles - Open and closed loop systems - Components for electronic engine management - Electronic management of chassis system - Vehicle motion control, Occupant-protection systems- Seat belts & Air bags - Introduction to super capacitor.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kirpal Singh, “Automobile Engineering”,Vol.1&2, 13th Edition, Standard Publishers 2013.
2. Jain and Asthana, “Automobile Engineering”,Mc Graw Hill Education,2017.

REFERENCES:

1. R.K.Rajput, , “Automobile Engineering” , Laxmi Publications,2015.
2. Gill, P.S., “A text book of Automobile Engineering”, Vol. 1&2, S.K. Kataria & Sons, 2012.
3. Robert Bosch Gmbh, “ Bosch Automotive Electrics and Automotive Electronics”, 5th edition Springer,2015.
4. J. Y. Wong , “Theory of Ground vehicles”, John Wiley & Sons INC, 3rd edition, 2001.

e-RESOURCES:

1. nptel.ac.in/courses/125106002/Dr. R. Ravi Chandran et. al.,IIT Chennai,Vehicle dynamics.
2. https://www.dieselnet.com/standards/in/

21MET53 METROLOGY AND MEASUREMENTS L T P C
3 0 0 3

Preamble:

Metrology and Measurements course enable the students to impart knowledge on various metrological equipment available to measure the dimension of the components and to provide knowledge on the correct procedure to be opted to measure the dimension of the components.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the basics of measurements to apply in the metrological instruments
2. Outline the principles of linear and angular measurement tools used for industrial applications
3. Explain the procedure for conducting computer aided inspection
4. Measure screw thread parameters using floating carriage micrometer and gear parameters using Parkinson gear tester.
5. Discuss the measuring techniques of mechanical properties in industrial applications.

UNIT 1 BASICS OF MEASUREMENT 9

Introduction to metrology, fit and tolerance – Need for measurement – Methods of measurement – Generalized measuring system. Units, standards. Measuring instruments – Deflection and null type instruments – Analog and digital instruments.

Sensitivity, Stability, Readability, Range of accuracy, precision (Qualitative treatment only). Errors in measurement – Types of errors – systematic and random errors. Calibration and Interchangeability.

UNIT 2 LINEAR AND ANGULAR MEASUREMENTS 9

Linear measuring instruments - Types - Limit gauges - Vernier caliper, Micrometer, Slip gauges - Optical flat. Comparators - Mechanical, Electrical, Pneumatics.

Angular measuring instruments – Sine bar – Classifications – Sources of errors. Bevel Protractors – Vernier, Universal, Optical – Clinometers. Autocollimator – Angle dekkor – Applications.

UNIT 3 LASER AND ADVANCES IN METROLOGY 9

Basic concept of lasers, Advantages of lasers – laser interferometer – types – Michelson interferometer – DC and AC interferometer - Applications.

Basic concept of Coordinate measuring machine (CMM) – Types – constructional features – probes – errrors, calibration and performance. Basic concept of Machine vision system – Element – Applications.

UNIT 4 FORM MEASUREMENT 9

Screw thread measurement – Terminology, Thread gauges – Floating carriage micrometer – gear measurement – Types of gears – Gear terminology – Spur gear measurement – Parkinson gear tester – Gleason gear testing machine.

Principles and methods of Straightness – Straightness test using spirit level and autocollimator - Flatness measurement – Surface finish measurement – types.

UNIT 5 MEASUREMENT OF MECHANICAL PARAMETERS 9

Measurement of forces – Direct methods – Equal arm balance and unequal arm balance, Indirect methods – Accelerometers, Load cells, Bourdon tube. Torque measurements – Methods – Strain gauges, Torsion bars. Measurement of power – Mechanical and DC dynamometers, Eddy current dynamometers. Measurement of flow – Hot wire anemometer, Ultrasonic flow meter. Temperature measurement – Bimetallic strip, Pyrometers, Thermocouples, Electrical resistance thermometer, Thermistors.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Thomas G.Beckwith, Roy D, Marangoni and John H.Lienhard V., “Mechanical Measurements”, Pearson Education, 2014.
2. Jain R.K., “Engineering Metrology”, Khanna Publishers, 2010.

REFERENCES:

1. Raghavendra, Krishnamurthy, “Engineering Metrology and Measurements”, OUP India, 2013.
2. R.K.Rajput, “A Textbook of Measurements & Metrology”, Katson publishers 2013.
3. Holman J.P., “Experimental Methods for Engineers”, McGraw-Hill Higher Education, 2012.

e-RESOURCES:

1. http://www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html
   Prof.S.P.Venkateshan, , IIT Madras, Mechanical Measurement and Metrology.
2. http://www.nptel.ac.in/courses/112106139/
   Prof.S.P.Venkateshan, IIT Madras, Mechanical Measurement and Metrology.

21MEL51 **COMPUTER AIDED DESIGN LABORATORY** **L T P C**
0 0 2 1

Preamble:

Computer Aided Design laboratory provides digitally integrated environment where the users can design, analyze, simulate and build components. Engineering drawing entails the use of graphical symbols such as points, lines, curves, planes and shapes. Essentially, it gives detailed description about any component in a graphical form.

Course Outcomes: Upon completion of the course, students will be able to:

1. Perform the part modelling and assembly drawing of couplings with the application of CAD software.
2. Prepare the part modelling and assembly drawing of Plummer block and screw jack with the application of CAD software.
3. Perform the part modelling and assembly drawing of universal and knuckle joints with the application of CAD software.
4. Perform the part modelling and assembly drawing of stuffing box with the application of CAD software.
5. Prepare the part modelling and assembly drawing of engine parts with the application of CAD software.

LIST OF EXPERIMENTS

1. Study of Fits and Tolerances

Preparation of part modelling and assembly drawing of following machine components using CAD software:

2. Flange Coupling.
3. Muff Coupling.
4. Plummer Block.
5. Screw Jack.
6. Universal Joint.
7. Knuckle joint.
8. Stuffing Box.
9. Connecting Rod.
10. Piston.
11. Crosshead.

TOTAL : 45 PERIODS

21MEL52 DYNAMICS AND METROLOGY LABORATORY L T P C

0 0 2 1

Preamble:

This course is an integration of both Dynamics and Metrology laboratories. The Dynamics part provides the students with the knowledge on determination of the cam characteristics, governor characteristics and mass moment of inertia of the given objects, frequency of free and damped vibrations and balancing of masses. The Metrology part imparts the knowledge on calibration of precision measuring instruments, angular measurements, measurement of gear / screw parameters and inspection using comparators.

Course Outcomes: Upon completion of the course, students will be able to:

1. Estimate the gyroscopic couple and critical speeds of shafts using gyroscope and whirling of shafts apparatus.
2. Determine the natural frequency of vibration of beams, shafts and springs using cantilever beam, single rotor system and spring mass system.
3. Construct the characteristic curves for governors using universal governor apparatus.
4. Estimate gear tooth dimensions, angles and screw thread parameters using Gear tooth vernier, Floating carriage micrometer, Profile projector and Tool maker's microscope.
5. Measure temperature, force, torque and vibration using temperature and force measuring instruments, torsion bars and vibration setup.

STUDY EXPERIMENTS

1. Determination of mass moment of inertia using bifilar suspension.
2. Balancing of rotating masses.
3. Calibration of precision measuring instruments - Vernier Caliper, Micrometer and Vernier Height Gauge.
4. Inspection of specimens using mechanical and electrical Comparators.

LIST OF EXPERIMENTS

1. Determination of characteristics of:
   a.) Gyroscope.
   b.) Governors- Proell and Hartnell.
2. Cams – Jump speed measurement.
3. Determination of natural frequency for undamped torsional vibration of single rotor system.
4. Determination of frequency of damped vibration of spring mass system.
5. Whirling of shafts apparatus– Determination of critical speeds of shafts with concentrated loads.
6. Forced Vibration of Cantilever beam – Natural frequencies.
7. Measurement of taper angle using Sine Bar and Sine Center.
8. Measurement of angular dimension of the given workpiece using Bevel Protractor and bore gauge
9. a.) Measurement of gear parameters using Gear Tooth Vernier.
   b.) Measurement of gear and screw parameters using Profile Projector.
   c.) Measurement of gear and screw parameters using Tool Maker's Microscope.
   d.) Measurement of screw thread parameters using Floating Carriage Micrometer.
10. a.)Measurement of temperature using temperature measuring instrument.
    b.) Measurement of vibration using vibration setup.
    c.) Measurement of force using force measuring instrument.
    d.) Measurement of torque using torsion bars.

TOTAL : 45 PERIODS

21MCT05	APTITUDE AND LOGICAL REASONING	L T P C
	(Common to All Branches in Fifth Semester**)**	**2 0 0 0**

Preamble:

Aptitude tests are used to determine an individual's ability/potential to succeed in a certain task, with no prior knowledge or training and are frequently used as part of a pre-employment assessment. Aptitude tests are a proven tool used to identify those who are best equipped to carry out any given role.

A logical reasoning test is a form of testing that is widely used by corporate employers to help assess candidates during their recruitment process.

Course Outcomes: Upon completion of the course, students will be able to

1. Solve the given equation using appropriate simplification methods.
2. Apply aptitude method of ratio and proportion to solve the given scenario.
3. Calculate time, speed, distance by applying suitable aptitude method for the given problem statement.
4. Calculate percentage and profit & loss for the given problem statement.
5. Compute simple interest, compound interest and predict relationship for the given problem/scenario.

UNIT 1

Number System, Simple Equation, Sequence and Series

UNIT 2

Ratio and Proportion, Problems on Ages, Partnership

UNIT 3

Time and Distance, Problems on Trains, Boats and Streams

UNIT 4

Percentage, Profit and Loss, Directions Sense

UNIT 5

Simple Interest and Compound Interest, Blood Relations

TOTAL : 30 PERIODS

REFERENCES:

1 Dr.R.S.Aggarwal, “Quantitative Aptitude for Competitive Examination”, S.Chand Publications, 2017

2 Dr.R.S.Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S.Chand Publications, 2018

21MCL09	COMMUNICATION SKILLS LABORATORY	L T P C
	(Fifth /Sixth Semester)	0 0 2 0

Preamble:

Communication Skill is a life skill necessary for all students of Engineering and Technology. The course Communicative Skills Laboratory aims at developing effective oral and written communication to facilitate their success in competitive examinations, and recruitment screening thereby ensuring professional success and progress.

Course Outcomes: Upon completion of the course, students will be able to:

1. Respond quickly and correctly to questions from different types of scripts , exhibiting good comprehension and analyzing skills
2. Participate effectively in formal group discussions and prepare professional e mails, persuasive and expository paragraphs to establish and meet organizational needs and goals.
3. Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time.
4. Write effective resumes, and face interviews with communicative competence and confidence, with a good knowledge of career skills.
5. Select appropriate vocabulary and idiomatic expressions, identify errors in syntax, arrange sentences to make meaningful paragraphs, without any aid.

UNIT 1 RECEPTIVE SKILLS **6**

LISTENING & READING – Developing Listening & Reading Skills - Comprehension and Analysis –Listening & Reading for Main Idea - Specific Information - Sequence-Vocabulary - Cultural Interest-Attitude and Opinion- Functional language.

UNIT 2 PRODUCTIVE SKILLS **8**

SPEAKING - Group Discussion skills – Structure- Types- Techniques - Keywords -Vital qualities - Tips to improve performance. **WRITING** - Emails and Paragraph Writing - Expository and Persuasive

UNIT 3 ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS **4**

Orientation to International English Language Testing System (IELTS), Public Service Commission Exams (TNPSC, UPSC)

UNIT 4 CAREER SKILLS **6**

Different types of Interview formats - Answering Questions – FAQ's - Mock Interviews - Body Language - Preparation of Résumé and Job Application Letter - Team Work - Managing Time - Managing Stress - Negotiation Skills - Networking Professionally - Social Protocols – Upskilling

UNIT 5 VERBAL ABILITY **6**

Synonyms and Antonyms - Verbal Analogy - Cloze Test- Idioms and Phrases - Sentence Completion - Jumbled Sentences - Error Spotting - Theme Detection - Sentence Arrangement

TOTAL : 30 PERIODS

RECOMMENDED SOFTWARE: Globerena

REFERENCES:

1. Rizvi M.Ashraf 'Effective Technical Communication' MC Graw Hill Education, New Delhi,2005.
2. Koneru Aruna 'Professional Communication' MC Graw Hill Education ,Chennai, 2008.
3. Upadhyay Meenakshi & Arun Sharma 'Comprehension Interpersonal & Communication Skills for General Studies Civil Services Preliminary Examination' MC Graw Hill Education, New Delhi,2012.

e-RESOURCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. https://www.teachingenglish.org.uk/article/email-writing
3. https://www.naukri.com/blog/frequently-asked-hr-interview-questions-and-answers/
4. http://www.oxforddictionaries.com/words/writing-job-applications
5. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers

21MET61 DESIGN OF TRANSMISSION SYSTEMS L T P C
3 1 0 4

Preamble:

This course provides design of various transmission devices which aid in effective working of mechanical systems. It introduces concepts associated with devices such as design of belt drives, chain drives, gear drives and gearboxes. Apart from these, this course give detailed view about design of cams, clutches and brakes.

Course Outcomes: Upon completion of the course, students will be able to:

1. Determine performance requirements in the selection of commercially available transmission drives.
2. Choose the suitable flexible drive for a given application using standard codes.
3. Explain the nomenclature of various types of gears and gear boxes based on load and speed requirements.
4. Analyze and compute various design parameters of cams and brakes for a given application.
5. Identify and explain the applications of the various systems, materials used to make them, and methods used.

UNIT 1 DESIGN OF FLEXIBLE ELEMENTS 12

Selection of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Selection of Transmission chains and sprockets.

UNIT 2 DESIGN OF PARALLEL GEARS 12

Gear Terminology - Force analysis - Tooth stresses - Dynamic effects - Fatigue strength – Factor of safety - Gear materials – Module and face width - Power rating calculations based on strength and wear considerations.

Parallel helical gears – Kinematics – Tooth proportions – Force analysis – Stresses in helical gear – Design of helical gear.

UNIT 3 DESIGN OF NON-PARALLEL GEARS 12

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 4 DESIGN OF GEAR BOXES 12

Geometric progression - Standard step ratio - Ray diagram, Kinematics layout - Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box.

UNIT 5 DESIGN OF CAMS, CLUTCHES AND BRAKES 12

Cam Design: Types - Pressure angle and under cutting base circle determination - Forces and surface stresses – Design of plate clutches.

Band and Block brakes - External shoe brakes – Internal expanding shoe brakes.

TOTAL : 60 PERIODS

DATA BOOK: (Allowed for reference during Examinations also)

1. P.S.G. Tech., Machine Design Data Hand Book.

TEXT BOOKS:

1. Shigley, J.E. and Mischke, C. R., "Mechanical Engineering Design", 10th edition, McGraw-Hill Education, New York, 2014.
2. Bhandari, V.B., "Design of Machine Elements", Fourth edition, McGraw Hill Education India Private Limited, New Delhi, 2016.

REFERENCES:

1. Juvinall, R.C. and Marshek, K.M., "Fundamentals of Machine Component Design", Fifth Edition, John Wiley & Sons, New York, 2011.
2. Norton, R.L., "Design of Machinery", Fifth Edition, McGraw-Hill Education, New York, 2011.
3. Hamrock, B.J., Jacobson, B. and Schmid S.R., "Fundamentals of Machine Elements", Fourth edition, McGraw-Hill Education, New York, 2013.
4. Maitra, G.M. and Prasad L.V., "Hand book of Mechanical Design", Second Edition, Tata McGraw-Hill, New Delhi, 1985.

e-RESOURCES:

1. http://freevideolectures.com/Course/2353/Power-Systems-Analysis/11
   Prof. A.K. Sinha, IIT Kharagpur, Transmission Systems.
2. http://www.nptelvideos.in/2012/12/design-of-machine-elements.html
   Prof. G. Chakraborty, Department of Mechanical Engineering, IIT Kharagpur, Design of Brakes.

21MET62 **HEAT AND MASS TRANSFER** **L T P C**
3 1 0 4

Preamble:

Heat and mass transfer are of great practical importance in many branches of science and engineering. Heat transfer addresses the transport of energy due to conduction, convection and radiation in almost all areas of science and engineering. Mass transfer specifically refers to the relative motion of species in a mixture due to concentration gradients. In many industrial and scientific applications, heat transfer processes occur simultaneously with mass transfer processes.

Course Outcomes: Upon completion of the course, students will be able to:

1. Solve the one-dimensional conduction heat transfer under steady and unsteady states, subjected to appropriate boundary conditions.
2. Analyze the convection heat transfer problems related to laminar and turbulent flows in different configurations.
3. Illustrate about thermal radiation exchange between black and gray surfaces.
4. Classify the various types of condensation processes in the heat exchangers.
5. Describe the equivalent non-dimensional numbers and their relative effects of various parameters governing mass transfer.

UNIT 1 CONDUCTION **15**

Basic Concepts –General Differential equation of Heat Conduction– Cartesian Coordinates – One Dimensional Steady State Heat Conduction — through Plane Wall, Cylinders, Spherical and Composite Systems – Conduction with Internal Heat Generation- plane wall and solid cylinder - Extended Surfaces- Pin fin, Longitudinal fin, Circumferential fin – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts.

UNIT 2 CONVECTION **12**

Basic Concepts –Heat Transfer Coefficients – Boundary Layer Concept – Types of Convection – Forced Convection – Dimensional Analysis – External Flow – Flow over Plates, Cylinders– Internal Flow – Laminar and Turbulent Flow – Combined Laminar and Turbulent flow over Bank of tubes - Free Convection in Vertical Plate, Horizontal Plate.

UNIT 3 RADIATION **12**

Introduction, Wave theory and quantum theory- concepts of black body and gray body - Stefan - Boltzman law - emissive power – monochromatic emissive power - Weins law - Kirchoff's law (elementary treatment only). Radiative properties - Emissivity, absorptivity, reflectivity, transmissivity, radiosity - Radiation shape factor - Reciprocity theorem. Heat exchange between black and gray surfaces- Reradiating surfaces.

UNIT 4 MASS TRANSFER AND PHASE CHANGE HEAT TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations- Boiling -Pool boiling and flow boiling- Condensation-drop wise and film wise (elementary treatment only).

UNIT 5 HEAT EXCHANGERS AND HEAT PIPES **12**

Basic Concepts - Types of heat exchangers - Parallel flow- Counter flow- Cross flow heat exchangers- Overall heat transfer coefficient- LMTD and NTU methods- Fouling in heat exchangers- Heat exchangers with phase change - Heat Pipes - Introduction, types and applications (elementary treatment only).

TOTAL : 60 PERIODS

DATA BOOKS:(allowed for reference during examinations also)

1. Kothandaraman.C.P, Subramanyan.S, "Heat and Mass Transfer Data Book", 8th edition, New age International, 2016.
2. Khurmi.R.S, "Steam Tables", 8th edition, S.Chand Publishers, 2015.

TEXT BOOKS:

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", 5th Edition, McGraw Hill Education, 2015.
2. Sachdeva.R.C, “Fundamentals of Engineering Heat and Mass Transfer”, 5th Edition, New Age International, 2017.

REFERENCES:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", 11th Edition, John Wiley & Sons, 2013.
2. Holman, J.P., "Heat and Mass Transfer", 9th Edition, McGraw Hill Education, 2011.
3. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", 4th Edition, New Age International, New Delhi, 2020.
4. Nag, P.K., "Heat Transfer", 3rd Edition, McGraw Hill Education, New Delhi, 2011.
5. Venkateshan. S.P., "Heat Transfer", 3rd Edition, Ane Books, New Delhi, 2016.

e-RESOURCES:

1. http://nptel.ac.in/courses/112101097/
   Prof. S. P. Sukhatme, Indian Institute of Technology, Bombay, Heat and Mass Transfer.
2. https://ocw.mit.edu/courses/mechanical-engineering/2-051-introduction-to-heat-transfer-fall-2015/download-course-materials/
   Prof. Kripa Varanasi, Massachusetts Institute of Technology, Introduction to Heat Transfer.

21MET63 **FINITE ELEMENT ANALYSIS** **L T P C**
3 1 0 4

Preamble:

The finite element analysis (FEA) is the most widely used method for solving problems of engineering and mathematical models. Typical problem areas of interest include the traditional fields of structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The FEA is a particular numerical method for solving partial differential equations in two or three space variables.

Course Outcomes: Upon completion of the course, students will be able to:

1. Identify and explain a mathematical model for solving engineering problems.
2. Analyze 1-D finite elements and build the stiffness matrix.
3. Solve the vector variable problems using two dimensional elements.
4. Solve the time-dependent and non-linear problems by applying discretization methods.
5. Explain the principles of finite element analysis in iso-parametric applications.

UNIT 1 INTRODUCTION **12**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Weighted Residual Methods – Variational Formulation of Boundary Value Problems –Rayleigh Ritz Technique – Basic concepts of the Finite Element Method - Matrix solution techniques.

UNIT 2 ONE-DIMENSIONAL PROBLEMS **12**

One Dimensional Second Order Equations – Discretization – Element types- Linear bar– Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – beam element – nodal approximation – shape functions – element matrices and vectors – assembly – solution – example problems.

UNIT 3 TWO-DIMENSIONAL PROBLEMS **12**

Introduction – approximation of geometry and field variable – 3 noded triangular elements – four noded rectangular elements – higher order elements (Qualitative Treatment only) – generalized coordinates approach to nodal approximations – structural mechanics applications in 2-dimensions – elasticity equations – stress strain relations – plane problems of elasticity – element equations – assembly– example problems in plane stress, plane strain and axisymmetric applications – Body forces and temperature effects – Stress calculations – Application to Field Problems - Thermal problems.

UNIT 4 DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD **12**

Introduction – vibrational problems – equations of motion based on weak form – longitudinal vibration of bars – transverse vibration of beams – consistent mass matrices – Lumped mass matrices – element equations –solution of eigenvalue problems – vector iteration methods – normal modes – transient vibrations – modelling of damping

UNIT 5 ISOPARAMETRIC FORMULATION **12**

Natural co-ordinate systems – Isoparametric elements – Shape functions and Element stiffness matrix and force vector for iso parametric elements – two dimensions – Numerical integration – Gaussian quadrature – Introduction to Analysis Software. Application of FEA.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, McGraw-Hill Education, 2014
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2014

REFERENCES:

1. Rao, S.S., “The Finite Element Method in Engineering”, 5th Edition, Butterworth Heinemann (Elsevier), 2016
2. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2015
3. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 4th Edition, Prentice Hall College Div, 2014

e-RESOURCES:

1. http://nptel.ac.in/courses/112104115/Prof. C.S. Upadhyay, IIT Kanpur, Finite Element Method
2. https://www.edx.org/course/finite-element-method-fem-analysis-tsinghuax-70120073x-1

21MEL61 **DESIGN AND FABRICATION PROJECT** **L T P C**
0 0 6 3

Preamble:
This course is designed to give an opportunity to the students to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them. Encourage the students through the option of Intellectual property protection on a novel work or to keep it in public domain as they may deem fit.

Course Outcomes: Upon completion of the course, students will be able to:
1. Discover potential research areas in the field of Mechanical Engineering.
2. Compare and contrast the several existing solutions for the problems identified.
3. Formulate and propose a plan for creating a solution for the research plan identified.
4. Conduct the experiments as a team and interpret the results.
5. Report and present the findings of the work conducted.

GUIDELINE FOR REVIEW AND EVALUATION
The students may be grouped into 2 to 4 and to work under a project supervisor. The device/ system/component(s) to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group and the fabricated model, which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by internal examiners and guide constituted by the Head of the Department.

21MEL62 SIMULATION AND ANALYSIS LABORATORY L T P C

0 0 2 1

Preamble:

Finite Element Analysis is a numerical method used for the prediction of how a part or assembly behaves under given conditions. It is used as the basis for modern simulation software and helps engineers to find weak spots, areas of tension, etc. in their designs. The results of a simulation based on the FEA method are usually depicted via a color scale that shows for example the pressure distribution over the object.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the structural problems in cantilever, simply supported, fixed end beams using analysis software.
2. Estimate the stress and deflection for Axi-symmetric component.
3. Analyze the given component under thermal condition using analysis software.
4. Validate simple dynamic problem through analysis software.
5. Develop MAT Lab program to simulate CAM follower mechanism, Hydraulic and Pneumatic system.

LIST OF EXPERIMENTS

PART A. SIMULATION

1. Simulation of simple problems in vibration using MAT Lab/SciLAB
2. Simulation of Hydraulic / Pneumatic cylinder using MAT Lab/SciLAB.
3. Simulation of cam and follower mechanism using MAT Lab/SciLAB.

PART B. ANALYSIS

4. Force and Stress analysis using link elements in Truss.
5. Stress and deflection analysis in beams (Cantilever, simply supported, Fixed ends) with different support conditions.
6. Stress analysis of a plate with a circular hole and L-bracket
7. Stress analysis of axi – symmetric components (Columns,Thick & Thin Cylinders)
8. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends).
9. Harmonic analysis of beams (Cantilever, Simply supported, Fixed ends).
10. Thermal stress and heat transfer analysis of plates (Conduction and Convection).
11. Study of Multibody Dynamics (Automobiles)

TOTAL : 45 PERIODS

21MEL63 HEAT AND MASS TRANSFER LABORATORY L T P C

0 0 2 1

Preamble:

Heat transfer laboratory course provides the students with the knowledge on fundamental concepts in the area of heat transfer such as conduction, convection and radiation and also heat transfer phenomena predict the relevant coefficient using implementation and the performance of fluidized bed cooling tower / components.

Course Outcomes: Upon completion of the course, students will be able to:

1. Determine the thermal conductivity of lagged pipe, composite wall and insulating powder.
2. Analyse and interpret heat transfer parameters by conducting experiments on natural and forced convection apparatus.
3. Determine the effectiveness of parallel flow and counter flow heat exchangers.
4. Determine the emissivity of grey surface and Stefan Boltzmann Constant.
5. Analyse the performance of a fluidized bed cooling tower.

LIST OF EXPERIMENTS

1. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
2. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
3. Determination of heat transfer coefficient under Forced convection from a tube.
4. Heat transfer from pin-fin apparatus (Forced convection mode).
5. Determination of thermal conductivity of composite wall.
6. Determination of thermal conductivity of insulating powder.
7. Determination of Stefan-Boltzmann constant.
8. Determination of emissivity of a grey surface.
9. Effectiveness of Parallel/ Counter flow heat exchanger.
10. Performance test in a fluidized bed cooling tower.

TOTAL : 45 PERIODS

21MCT07	ARITHMETIC AND ANALYTICAL ABILITY (Common to All Branches in Sixth Semester)	L T P C 2 0 0 0

Preamble:

Arithmetic and Analytical Ability evaluates the talent and potential to perform a certain task, with no prior knowledge and/or training. This course deals with sort of problems on dynamic thinking, numeric capacity and spatial question. This course is further used for prediction of future success both in educational and vocational careers and aptitude skills help the students in the proper choice of courses and careers.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compute time, work, capacity and identify the pattern by analyzing the given problem/scenario.
2. Analyze the given problem involving mixture, averages, seating arrangement and apply the suitable method to get the appropriate result.
3. Interpret the given chart and determine the solution.
4. Identify and apply the appropriate permutation, Combination, probability technique to determine the solution.
5. Infer the solution for the given scenario involving syllogisms, clocks, calendar using suitable techniques.

UNIT 1 **6**

Time and Work, Pipes and Cisterns, Symbol Series

UNIT 2 **6**

Alligation or Mixture, Averages, Seating Arrangements

UNIT 3 **6**

Data Interpretation-Table Charts, Bar Charts, Pie Charts, Line Charts

UNIT 4 **6**

Permutation and Combination, Probability

UNIT 5 **6**

Syllogisms, Clocks, Calendar

TOTAL : 30 PERIODS

REFERENCES:

1. Dr.R.S.Aggarwal, “Quantitative Aptitude for Competitive Examination”, S.Chand Publications, 2017
2. Dr.R.S.Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S.Chand Publications, 2018

21MET71 **TOTAL QUALITY MANAGEMENT** **L T P C**
3 0 0 3

Preamble:
Total Quality Management is an enhancement to the traditional way of doing business. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach. At the end of the course the students are expected to recognize the quality issues in an organization and analyze the ways to solve those using TQM techniques, and demonstrate skills in using modern TQM tools and software to analyze problems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Identify and explain the principles of quality management and dimensions of quality can be applied within quality management systems to attain customer satisfaction.
2. Appraise the organizational, communication and teamwork requirements for effective quality management
3. Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.
4. Apply various statistical tools to measure quality and customer satisfaction.
5. Analyze the elements, documentation and environmental issues using quality systems to attain organizational standards.

UNIT 1 BASICS OF TQM **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - TQM - TQM framework - Contributions of Deming, Juran and Crosby - Barriers to TQM.
Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT 2 TQM PRINCIPLES **9**

Leadership - Strategic quality planning, Quality councils - Employee involvement - Motivation, Empowerment, Team and teamwork, Quality circles -Recognition and reward, Performance appraisal.
Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection and Supplier rating.

UNIT 3 TQM TOOLS AND TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six Sigma: Concepts of Six Sigma, Methodology, Applications to manufacturing and service sectors including IT.
Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT 4 TQM TOOLS AND TECHNIQUES II **9**

Control charts, Process capability - Quality function deployment (QFD) - Taguchi quality loss function – Total productive maintenance (TPM) - Concepts, Improvement needs - Performance measures - Just in Time.

UNIT 5 QUALITY SYSTEMS **9**

Need for ISO 9000 - ISO 9001-2015 Quality system - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM implementation in manufacturing and service sectors - OSHAS 18000 – Concept requirements and benefits – Case studies.

TOTAL : 45 PERIODS

Control chart for variables will be provided for Examination.

TEXT BOOKS:

1. Dale H. Besterfiled et. al., "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2013.
2. Subburaj Ramasamy, “Total Quality Management”, McGraw Hill Education , Noida, 2011.

REFERENCES:

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, “Total Quality Management”, PHI Learning New Delhi, 2011.
3. Mukherjee, P.N., “Total Quality Management”, PHI Learning New Delhi, 2010.

e-RESOURCES:

1. http://nptel.ac.in/courses/110105039/10
   Dr. T. P. Bagchi, Department of Management, IIT Kharagpur, Six Sigma.
2. http://www.learnerstv.com/video/Free-video-Lecture-18833-Management.html
   Dr. T. P. Bagchi, Department of Management, IIT Kharagpur, Quality Function Deployment.

21MEC72 **MECHATRONICS** **L T P C**
3 0 2 4

Preamble:
This course imparts the knowledge on applications of the fluid power system in machine tools and It provides knowledge about sensors, actuators, Microprocessor, Microcontroller, and PLC. It teaches knowledge on interfacing of devices with controllers.

Course Outcomes: Upon completion of the course, students will be able to:

1. Draw symbols used in fluid power systems.
2. Distinguish 3/2 and 4/2 way valves, accumulators and intensifiers.
3. Design basic pneumatic circuits for speed control and sequential circuit applications and explain the function of Filter, Regulator, and Lubricator in a pneumatic system.
4. Select suitable sensors and motors to meet specific requirements.
5. Discuss the architecture of 8085 microprocessor, 8051microcontroller and Programmable Logic Controllers.
6. Simulate hydraulic and pneumatic using software tool and trainer kit.

UNIT 1 FLUID POWER SYSTEMS AND FUNDAMENTALS 10

Introduction to fluid power - Advantages of fluid power - Applications of the fluid power system - Types of fluid power systems - Properties of hydraulic fluids - General types of fluids - Fluid power symbols.
Applications of Pascal's Law, Pump classification - Construction & Working of Gear pump, Vane Pump, Piston pump.

UNIT 2 HYDRAULIC SYSTEM & COMPONENTS 10

Fluid Power Actuators: Linear hydraulic actuators - Types of hydraulic cylinders- Single acting, Double acting - Rotary actuators. Introduction to hydraulic motors. Directional control valve - 3/2 way valve - 4/2 way valve - Shuttle valve - Check valve -Pressure control valve - Sequence valve, Flow control valve.
Accumulators and Intensifiers: Types of accumulators - Accumulators circuits, Intensifier - Intensifier circuit and Applications.

UNIT 3 PNEUMATIC SYSTEMS AND COMPONENTS 10

Pneumatic Components: Properties of air - Compressors - Filter, Regulator and Lubricator Unit - Air control valves, Quick exhaust valves and Pneumatic actuators. Pneumatic circuits-Speed control circuit, Sequential circuit design for simple applications using Cascade method. .
Introduction to Electro Hydraulic Pneumatic logic circuits, Ladder diagrams, Applications of PLC in fluid power control, Servo systems- Hydro Mechanical servo systems only.

UNIT 4 SENSORS AND ACTUATORS 10

Introduction to Mechatronics, open and closed control systems, Overview of sensors and transducers for measuring Displacement, position, and proximity –(Potentiometer sensors, Strain-gauged elements, Capacitive elements, Differential transformers, Eddy current proximity sensors, Optical encoders,
Pneumatic sensors, Proximity switches, and Hall effect sensors only).
Signal conditioning – Operational amplifiers – Protection – Filtering - Analog and Digital converters.
DC motors – Servomotors – Stepper motors

UNIT 5 MICRO PROCESSORS, MICRO CONTROLLERS AND PROGRAMMABLE LOGIC CONTROLLERS 10

Architecture of 8085 microprocessor– Pin Configuration, Architecture of 8051 microcontroller – Pin Configuration, interfacing with keyboard, display and motors. Application cases for temperature control pick and place robot, Engine management system.
Architecture of programmable logic controllers – Input /Output modules – Programming methods – Timers and counters – Master control and jump controls – Branching – Data handling – Analog input/output – Selection of PLC.

UNIT 6 PRACTICAL COMPONENT 10

1. Design and testing of sequential circuits in Electro pneumatic kit using PLC.
2. Simulation of Timer and counter functions using software.
3. Temperature and pressure control using PID controller.
4. Construction of ladder programming for simple Boolean operations.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th edition, 2013.
2. Bolton, W., “Mechatronics”, 4th Edition, Pearson Education, 2010.
3. R K Rajput, “Textbook of Mechatronics Paperback” –S Chand & Company,2007,ISBN-13: 978-8121928595.

REFERENCES:

1. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, Second edition
2. Majumdar.S.R., "Oil Hydraulics Systems- Principles and Maintenance", McGraw Hill Education, Reprint 2011.
3. Nitaigour Mahalik, “Mechatronics”, 3rd Edition, McGraw Hill Education, 2011
4. Musa Jouaneh, “Fundamentals Of Mechatronics”, Cengage Learning 2012.

e-RESOURCES:

1. https://nptel.ac.in/courses/112105047/
   Prof. R.N. Maiti, IIT Kharagpur.” Fundamentals of Industrial Oil Hydraulics and Pneumatics”.
2. https://classes.soe.ucsc.edu/cmpe118/Spring05/
   Dr. Ed Carryer, Jack Baskin School of Engineering, Introduction to Mechatronics.

21HST71 **HUMAN VALUES AND PROFESSIONAL ETHICS** **L T P C**

(Common to All Programmes)

3 0 0 3

Preamble:

Universal Human Values is a life skill necessary for all students of Engineering and Technology. The course aims to identify the values and skills, and to realize the need, basic guidelines, content and process of value education. Professional Ethics For Engineers deals with the human values, integrity and work ethics in the common world. This course is mainly concerned about the theories of ethics, which form the basis for the understanding and responsibility of the various groups encountered in Engineering.

Course Outcomes: Upon completion of the course, students will be able to:

1. Relate the significance of value inputs in a classroom and start applying them in their life and profession.
2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.
3. Interpret the value of harmonious relationships based on the trust and respect in their life and profession.
4. Discuss the ethical issues related to Engineering.
5. Discuss Engineer's work in the context of its impact on society.

UNIT 1 INTRODUCTION TO UNIVERSAL HUMAN VALUES **9**

Understanding the need, basic guidelines, content and process for Value Education. Self Exploration– Mechanism for self exploration. Continuous Happiness and Prosperity- Basic Human Aspirations and its requirements for fulfillment of Human Aspirations understanding and living in harmony at various levels.

UNIT 2 HARMONY IN ONESELF, FAMILY AND SOCIETY **9**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationships. Trust and Respect- values of relationship. Difference between intention and competence. Difference between respect and differentiation

UNIT 3 HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS **9**

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics. Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models.

UNIT 4 ENGINEERING ETHICS **9**

Senses of Engineering Ethics– Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and controversy – Models of professional roles –Professional responsibility - Moral reasoning - Theories about right action – Self interest – Self respect – Duty ethics – Customs and religion.

UNIT 5 ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as experimentation – Engineers as responsible experimenters – Role of codes- Codes of Ethics – Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE) – A balanced outlook on law - Safe exits -The Bhopal gas tragedy and Challenger case study.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gaur R R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics". 2009
2. Govindarajan M, Natarajan S and Senthil Kumar V. S, "Engineering Ethics", PHI Learning Pvt. Ltd, New Delhi, 2017.

REFERENCES:

1. Banerjee B P, “Foundations of Ethics and Management”, Excel Books. 2005.
2. Bajpai B L, “Indian Ethos and Modern Management”, New Royal Book Co., Lucknow. Reprinted 2008.
3. Subramanian R, “Professional Ethics”, Oxford university press, 2017.

e-RESOURCES:

1. https://www.uhv.org.in/
2. https://nptel.ac.in/courses/109/106/109106117/

21MEL71 **AUTOMATION LABORATORY** **L T P C**

0 0 2 1

Preamble:

This course is an integration of both Mechatronics and Computer aided manufacturing laboratories. The Mechatronics part provides the students with the knowledge on design and testing of the hydraulic, pneumatic and electric circuits using software, pneumatic trainer kits, electro pneumatic trainer kits , hydraulic trainer kit, PLC programming, PID controller, and microprocessor. The CAM part imparts the knowledge on part programing for various machining operations using software and CNC machine.

Course Outcomes: Upon completion of the course, students will be able to:

1. Model and analyze basic hydraulic, pneumatic and electrical circuits using automation software.
2. Design and test fluid power circuits using pneumatic, hydraulic, electro pneumatic trainer kits and PLC controllers.
3. Develop and test assembly level programmes for 8085 microprocessor and test speed control of stepper motor using 8051 micro controller
4. Develop the manual CNC part programming using standard G and M codes in CNC machines.
5. Perform machining operations in CNC machine to produce required components.

LIST OF EXPERIMENTS

1. Study of image processing technique and PID controller interfacing.
2. Design and testing of circuits using basic pneumatic trainer kits.
3. Design and testing of circuits with logic sequence using electro pneumatic trainer kits.
4. Design and testing of sequential circuits in electro pneumatic kit using PLC.
5. Design and testing of fluid power circuits to control.

(i) Velocity (ii) direction and (iii) force of single and double acting actuators

6. Simulation of basic hydraulic, pneumatic and electric circuits using software.
7. Addition, subtraction, multiplication, division of two 8 bit numbers using microprocessor kit.
8. Stepper motor interfacing with 8051 Micro controller.

(i) Full step resolution (ii) Half step resolution.

9. a. Manual part programming for multiple facing in CNC lathe.
   b. Manual part programming for single grooving in CNC lathe.
10. a. Manual part programming for simple contour milling.
    b. Manual part programming for mirroring cycle in CNC mill.

TOTAL : 45 PERIODS

21MEL72 **COMPREHENSION** **L T P C**
0 0 2 1

Preamble:

This course is to encourage the students to comprehend the knowledge acquired from the first Semester to Sixth Semester subjects in three broad streams Thermal and Fluids Engineering, Design Engineering, and Manufacturing Engineering of B.E Degree Course through periodic exercise.

Course Objective:

- The objective of comprehension is to provide opportunity for the student to apply the knowledge acquired during the earlier semesters to real life problems which he / she may have to face in future as an engineer.

- While learning as how to solve the real-life problems, student will receive guidance from the faculty and also review various courses learnt earlier.

- Further this comprehension is to achieve an understanding of the fundamentals of contemporary manufacturing systems including materials, manufacturing process, product and process control, computer integrated manufacture and quality.

- The students work in groups and solve a variety of problems given to them.

- The problems given to the students should be of real like industrial problems selected by a group of faculty members of the concerned department.

- A minimum of three small problems have to be solved by each group of students.

- The evaluation is based on continuous assessment by a group of Faculty Members constituted by the professor in-charge of the course.

- There will be three aptitude tests covering syllabus, general aptitude with GATE standard questions.

METHOD OF EVALUATION

The students will be assessed 100% internally through weekly test with objective type questions on all the subject related topics.

21MCT08 INDIAN CONSTITUTION AND TRADITIONAL KNOWLEDGE L T P C
2 0 0 0

Preamble :

The course provides basic information on Indian Constitution and Indian Traditional knowledge.This is essential for all citizens and especially for engineers so that they become aware of Indian polity and governance. This also reminds the citizen about their obligation, adherence and upkeeping of Constitutional rights.

Course Outcomes: Upon completion of the course, students will be able to:

1. Outline the evolution of Indian constitution and Federal structure
2. List the functions of Centre, States and District Administrations
3. Elaborate the roles of Panchayatiraj
4. Explain the powers and roles of Election Commission
5. Illustrate the Indian traditional knowledge and elucidate their recovery

UNIT 1 **6**

Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy - Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

UNIT 2 **6**

Governor: Role and Position, CM and Council of ministers, State Secretariat: organisation, Structure and Functions District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

UNIT 3 **6**

Panchayatiraj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT 4 **6**

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

UNIT 5 **6**

Basic structure of Indian Knowledge System- Modern Science and Indian Knowledge -Philosophical Tradition - Indian Linguistic Tradition (Phonology, morphology, syntax and semantics) - Indian Artistic Tradition

TOTAL: 30 PERIODS

TEXT BOOKS:

1. M.Rajaram, Indian Constitution, New Age International, 2009
2. V.Sivaramakrishnan (Ed.) Cultural Heritage of India (Course Material) , Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014

21MEL82	PROJECT WORK	L	T	P	C
		0	0	20	10

Preamble:

This course is designed to develop the ability to solve a specific problem right from its identification and literature review till the successful solution for the same. This course also trains the students in preparing project reports and in facing reviews and viva voce examination.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discover potential research areas in the field of Mechanical Engineering.
2. Compare and contrast the several existing solutions for the problems identified.
3. Formulate and propose a plan for creating a solution for the research plan identified.
4. Conduct the experiments as a team and interpret the results.
5. Report and present the findings of the work conducted.

GUIDELINE FOR REVIEW AND EVALUATION

The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee shall be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department. Progressive weightage shall be assigned to the project reviews as decided by the project review committee.

TOTAL: 180 PERIODS

21MEE11 **CAD / CAM / CIM** **L T P C**
3 0 0 3

Preamble:
Computer–aided design (CAD) involves creating computer models defined by geometrical parameters. These models typically appear on a computer monitor as a three–dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. Computer–aided manufacturing (CAM) uses geometrical design data to control automated machinery. CAM systems are associated with computer numerical control (CNC) or direct numerical control (DNC) systems. Computer–integrated manufacturing (CIM) is the manufacturing approach of using computers to control entire production process.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the implementation of a CAD system in a design process.
2. Apply the concept of parametric design in 2D Drafting.
3. Summarize the steps involved in Computer Aided Manufacturing and process planning.
4. Explicate the concepts of group technology and also the cellular manufacturing concepts.
5. Illustrate the concepts of flexible manufacturing system and automated guided vehicle system in the industrial sector.

UNIT 1 GEOMETRIC MODELLING TECHNIQUES **9**

CAD implementation – Design process – Shigley, Pahl and Beitz, Ohsuga, Earle model – Benefits of CAD – Hardware – Input and output devices – Display devices – LCD, LED – Geometric modeling – basics of wire frame, surface, solid modeling.

UNIT 2 PARAMETRIC DESIGN AND OBJECT REPRESENTATION **9**

Types of co-ordinate systems. Parametric design – Definition and advantages. Parametric representation of analytic and synthetic curves (Hermite curve– Bezier curve– B-spline curves). Automated 2D drafting – Basics, Mechanical assembly – Bill of materials generation. Mass property calculations.

UNIT 3 COMPUTED AIDED MANUFACTURING AND PROCESS PLANNING **9**

Function of CAM – Benefits of CAM – Integrated CAD/CAM organization – Computed aided process planning – Retrieval type CAPP, generative 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 –I (MRP-II) & Enterprise Resource Planning (ERP) –Simple Problems.

UNIT 4 COMPUTER INTEGRATED MANUFACURING AND CELLULAR MANUFACTURING **9**

Evolution of computer integrated manufacturing – CIM hardware and CIM software – nature and role of the elements of CIM system – Development of CIM 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 5 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 – Automated storage and retrieval system – Carousel retrieval system –Vehicle Guidance technology – Vehicle Management & Safety.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Radhakrishnan P and Subramanyan S, "CAD/CAM/CIM", New Age International Pvt. Ltd., 2012
2. Mikell. P. Groover "Automation, Production Systems and Computer IntegratedManufacturing", Pearson Education 2001.

REFERENCES:

1. Radhakrishnan P and Kothandaraman C P, "Computer Graphics and Design", DhanpatRai& Sons, New Delhi, 2014.
2. Chennakesava R Alavala, "CAD/CAM Concepts and its applications", 2nd ed., PHI Learning Ltd., (New Delhi), 2015

e–RESOURCES:

1. http://nptel.ac.in/courses/112102101/1
   Prof. Dr. AnoopChawlaetal.,IIT Delhi,Computer Aided Design and Manufacturing
2. https://ocw.mit.edu/courses/aeronautics–and–astronautics/16–810–engineering–design–and–rapid–prototyping–january–iap–2005/lecture–notes/l4.pdf
   Prof. Olivier de Weckетal., École Institute of Technology,Computer Aided Design

21MEE12 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

Preamble:
This course provides students a background in modern composite materials which are being used in an ever-increasing range of applications and industries. Basic knowledge of composite materials will allow engineers to understand the issues associated with using these materials, as well as gain insight into how their usage differs from conventional materials such as metals, and ultimately be able to use composites to their fullest potential. This course covers the fundamentals of composite material and manufacturing of various composite materials

Course Outcomes: Upon completion of the course, students will be able to:

1. Identify and explain the types of matrix materials and reinforcements used in composite materials based on the applications.
2. Explain the matrix materials used in the metal matrix composites and processing of MMCs by using solid and liquid state processing methods.
3. Describe the types of ceramic matrix composites and fabrication of CMC by pressing, infiltration and chemical processing methods.
4. Discuss the basics of polymers and its properties and fabrication techniques of polymer matrix composites by using various fabrication methods.
5. Select the appropriate composite material, based on the properties and advantages of advanced composite materials.

UNIT 1 FIBERS AND MATRIX MATERIALS **9**

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic fibers – Whiskers – Matrix materials – Polymers - Thermoplastics and Thermosets, Copolymers, Epoxy, Polyester - Metals and Ceramics – Interfaces – Wettability – Types of bonding at the interface.

UNIT 2 METAL MATRIX COMPOSITES **9**

Metallic matrices: Aluminium, titanium, magnesium, copper alloys – Processing of MMCs: Processing of MMC – Powder metallurgy process - diffusion bonding – stir casting – squeeze casting – mechanical properties – Machining of MMCs – Applications of MMCs.

UNIT 3 CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES **9**

Ceramic Matrix Materials - Bonding and structure, Effect of flaws on strength, Common ceramic matrix materials - Processing of CMCs: cold pressing, sintering, reaction bonding – Infiltration - liquid infiltration, lanxide process – In situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, solgel- interfaces in CMCs – mechanical properties and applications of CMCs.

UNIT 4 POLYMER MATRIX COMPOSITES **9**

Classification of Polymers – Properties of Thermo and Thermosetting Plastics – Extrusion, Polymer matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding Thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – Properties and application of PMCs – Recycling of PMCs.

UNIT 5 ADVANCED COMPOSITES AND MECHANICS OF COMPOSITES **9**

Nanocomposites - Polymer Clay Nanocomposites - Self-Healing Composites - Self-Reinforced Composites - Biocomposites - Laminates - Ceramic Laminates, Hybrid Composites- carbon nanofibers – carbon nanotubes (CNTs) – production and properties of CNTs.Micromechanics of Composites - Fatigue and Creep - Designing with Composites.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Krishnan K Chawla, “Composite Materials: Science and Engineering, 3rd Edition, Springer, 2012.
2. Louis A. Pilato· Michael J. Michno, “Advanced Composite Materials”, 1st Edition, Springer-Verlag Berlin Heidelberg GmbH, 1994.

REFERENCES:

1. Autar.K.Kaw, “Mechanics of Composite Materials”, CRC Press, 2011.
2. Hull D, Clyne TW., “Introduction To Composite Materials”, Cambridge University Press – New Delhi, 2010.
3. Raonald F Gibson, “Principles of Composite Material Mechanics”, CRC Press – London, 20116.

e-RESOURCES:

1. http://nptel.ac.in/courses/112104168/, Dr. Inderdeep Singh, Department of Mechanical Engineering, IITRoorkee, Processing of non-metals.
2. http://freevideolectures.com/Course/3479/Processing-of-non-metals/5, Prof. Nachiketa Tiwari, Indian Institute of Technology, Kanpur, Introduction to Composite Materials and Structures.

21MEE13 DESIGN AND ANALYSIS OF EXPERIMENTS L T P C
3 0 0 3

Preamble:
To introduce the student about the principles and methods of statistical analysis of experimental designs and provides knowledge on process/product optimization.

Course Outcomes: Upon completion of the course, students will be able to:
1. Select an appropriate design, conduct the experiment and interpret the result using appropriate statistical techniques.
2. Solve the problem by optimizing the product/process parameters.
3. Predict the outcomes through statistical concepts.
4. Demonstrate process/product optimization through statistical concepts.
5. Discuss the principles and methods of statistical analysis of experimental designs.

UNIT 1 EXPERIMENTS WITH A SINGLE FACTOR 9

Basic Principles and Guidelines of Design of Experiments - Single Factor Experiments – ANOVA - Model Adequacy Checking - Determining Sample Size - Comparing Pairs of Treatment Means - Introduction to DOAE software.

UNIT 2 RANDOMIZED BLOCK DESIGNS 9

Randomized complete block design - Latin square designs – Graeco-Latin square design - Balanced incomplete block designs Two levels - 2k factorial designs - Confounding and Blocking in factorial designs.

UNIT 3 FACTORIAL DESIGNS 9

Two levels - 2k factorial designs - Confounding and Blocking in factorial designs. Fractional Factorial Designs - The One-Half and One-Quarter Fraction of the 2k Design - General 2k–p Fractional Factorial Design – Resolution.

UNIT 4 ROBUST DESIGN and REGRESSION ANALYSIS 9

Comparison of classical and Taguchi's approach - orthogonal designs - S/N ratio - application to Process and Parameter design. Simple Linear Regression Analysis - Multiple Linear Regression Model - Model Adequacy Checking.

UNIT 5 RESPONSE SURFACE METHODOLOGY 9

Response surface methodology, parameter – optimization - robust parameter design and its application to control of processes with high variability.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. Douglas C. Montgomery, (2017), Design and Analysis of Experiments, John Wiley & Sons, Inc., 9th edition
2. K. Deb., Optimization for Engineering Design: Algorithms and Examples, PHI, 2nd Edition, 2012

REFERENCES:
1. Charles R. Hicks, Kenneth V. Turner (1999) Jr., Fundamental concepts in the Design of Experiments, Oxford University Press, 5th edition
2. K. Krishnaiah, P. Shahabuddeen (2012) Applied Design of Experiments and Taguchi Methods, PHI Publications.
3. Philip J. Rose, (2000), Taguchi Techniques for quality Engineering, Prentice Hall

e-RESOURCES:
1. https://nptel.ac.in/courses/110/105/110105087/
   Prof. Jhareswar Maiti, Department of industrial and system engineering, IIT Kharagpur, Design and analysis of experiments.
2. https://nptel.ac.in/courses/111/104/111104075/
   Dr. Shalab, Department of mathematics and statics, IIT Kanpur, Analysis of variance and Design of Experiments –I.

21MEE14 **MECHANICAL VIBRATIONS** **L T P C**
3 0 0 3

Preamble:
Any motion that repeats itself after an interval of time is called vibration or oscillation. One of the most important purposes of vibration study is to reduce vibration through proper design of machines and their mountings. And most vibrations produce high stresses, energy losses and wear. This course deals with fundamental concepts of vibration in various degrees of freedom systems and determinations of frequencies of vibration and also with vibration measurement and control.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the fundamental concepts of vibration pertaining to single degree of freedom for listing the types of vibration.
2. Describe the method of solving simple problems in torsional vibration related to two degree of freedom for estimating the frequency of vibration.
3. Solve simple problems in vibration associated with multi degree of freedom for calculating the natural frequency of vibration using a calculator.
4. Illustrate the vibration of continuous systems like shafts and beams for analyzing the vibration.
5. Interpret the vibration measurement and control techniques using specific devices like Transducer for the control of natural frequency of vibrations.

UNIT 1 SINGLE DEGREE OF FREEDOM SYSTEM **9**

Fundamentals of vibration- Sources of vibration- Types of vibration-Single Degree of Freedom –- Responses of undamped free vibration - Types of damping -Viscous damping - Damped free vibration - Reponses of undamped forced vibration and damped forced vibration – Vibration isolation and force transmissibility-Critical speed with damping.

UNIT 2 TWO DEGREE OF FREEDOM SYSTEM **9**

Equations of motions- Principle mode of vibration- Free, forced and torsional vibration of Undamped and damped system.

Torsional system-Spring coupled system – mass coupled system –coordinates coupling and principles coupling - Dynamic vibration absorber -Lagrange's equation.

UNIT 3 MULTI-DEGREE OF FREEDOM SYSTEM **9**

Introduction- Methods of determining natural frequencies of MDF system -Influence coefficients - Stiffness coefficients and Generalised coordinate – Eigenvalues and Eigen vectors.

Approximate methods in MDF: Determination of natural frequencies by Dunkerley's method, Matrix Method, Stodala Method, Matrix iteration method -Rayleigh's and Holzer's method.

UNIT 4 VIBRATION OF CONTINUOUS SYSTEMS **9**

Introduction - Lateral vibration of string - Longitudinal vibration of shaft - Torsional vibration of uniform shaft – Transverse vibration of beam - Systems governed by wave equations – Effect of Rotary inertia and shear deformation

UNIT 5 VIBRATION MEASUREMENT AND CONTROL **9**

Vibration measuring devices: Transducers, Vibration Pickups - Frequency Measuring Instruments - Vibration exciters–Types. Fast Fourier Transformation (FFT) Analyser. Case studies.

Control of vibration- Control of Natural frequencies - Introduction to damping- Balancing of Rotors -single plane and Two plane.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Singiresu S Rao, Mechanical Vibrations, Pearson Education, 2016.
2. Singh, V.P, Mechanical Vibrations, Dhanpat Rai & Co, 2016

REFERENCES:

1. Groover.G.K, Mechanical Vibrations, New Chand &Bros, Roorkee, 2014.
2. William T Thomson,. Theory of Vibration with Applications, Pearsol, 2013.
3. Balakumar Balachandran, , Edward B Magrab, Fundamentals of Vibrations, Cengage Learning,2009

e-RESOURCES:

1. https://nptel.ac.in/courses/112103112/
2. https://nptel.ac.in/courses/112103111/

21MEE15 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS L T P C
3 0 0 3

Preamble:
The course aims at giving adequate exposure to jigs, fixtures and press tools for holding the machining tool and workpiece during metal remove process and metal joining press within the specified tolerance.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explore the methods of locating and clamping principles.
2. Explain the design and development of jig and their types.
3. Illustrate the methods of fixtures principle.
4. Describe the function and principle of press working terminologies.
5. Discuss the computer aid design principle for sheet metal dies.

UNIT 1 LOCATING AND CLAMPING DEVICES 9

Introduction - Principles of Jigs and Fixtures Design - Locating principles - Locating Methods and devices - Standard parts - Principles of Clamping devices -Mechanical actuation - Pneumatic & hydraulic actuation - Analysis of clamping forces - Tolerance and error analysis.

UNIT 2 JIGS 9

Introduction of Jig - Drill bushes, types of bushes, Clearance between workpiece and bushing and defects - Elements of a Jig - Construction of Jigs - Materials for Jig Elements - Different types of jig - Automatic Drill jig - Rack and Pinon Indexing Device - Air operated drilling jig and components - Tips for selection of a jig.

UNIT 3 FIXTURES 9

Introduction of Fixture - Design Principles of Fixtures - Types of fixtures - General principles of Boring Fixtures - Classification of Boring Fixture - Types of Boring Fixture – Lathe fixture – Broaching Fixture – Milling Fixture -Grinding Fixture – Inspection fixture – welding fixture – Air operated Fixture – Air operated fixture

UNIT 4 PRESS TOOLS 9

Introduction – Press working terminology – Elements of Mechanical Presses – Types of Common Presses: Fly press, open back inclinable press, Straight side angle crank press, Eccentric press, Double action crank press, one point press, two point press, double and triple action press, friction screw press and hydraulic press – Principle Accessories of Common Press – Press Accessories (Dies and Punches) – Compound dies – Progressive Die – Combination Die – Stretch Press Die.

UNIT 5 FORMING TECHNIQUES AND EVALUATION 9

Bulging, Swaging, Embossing, coining, curling, hole flanging, shaving and sizing, assembly, fine Blanking dies – recent trends in tool design- computer Aids for sheet metal forming Analysis – basic introduction - tooling for numerically controlled machines- setup reduction for work holding – Single minute exchange of dies – Poka Yoke.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. C.Elanchezhian, T.Sunder Selwyn &B.Vijaya Ramnath, “Design of Jigs, Fixtures and Press Tools”, Eswer Press, 2nd Edition, 2007.
2. EdwrdG.Hoffman, “Jig and Fixture Design”, Cengage Learning, 7th edition, 2017.

REFERENCES:

1. IvanaSuchy, “Die Design Handbook”, McGraw Hill Book Co., 2005.
2. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017

e-RESOURCES:

1. https://nptel.ac.in/courses/112105126/ NPTEL IIT kharagpur
2. https://nptel.ac.in/courses/112/107/112107144/ NPTEL IIT Roorkee

21MEE16 **INDUSTRIAL TRIBOLOGY** **L T P C**
3 0 0 3

Preamble:
The concept of tribology was expressed in 1966. It includes the interdisciplinary science and technology of interacting surfaces in relative motion and associated subjects and practices. Even though the name tribology is new, the contents friction and wear are very old.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain topography and friction mechanisms of metals and non metals using knowledge of surface roughness of materials for knowing the effect of friction.
2. Illustrate the wear of materials to choose materials for adhesive and abrasive wear situations with reference of nature of wear.
3. Classify the lubricants and types of lubrication for selecting a lubricant which meets the need of particular lubrication.
4. Describe fluid film prevailing in bearing surfaces in working condition for recognizing the type of lubrication.
5. Select appropriate materials for various types of bearings for expected functionality compliance with Tribology Handbook.

UNIT 1 SURFACES AND FRICTION **9**

Topography of Engineering surfaces- Contact between surfaces – Sources of sliding Friction– Adhesion-Ploughing- Energy dissipation mechanisms- Friction Characteristics of metals.

Friction of non metals. Friction of lamellar solids – Friction of ceramic materials and polymers – Rolling Friction – Source of Rolling Friction – Stick slip motion – Measurement of Friction.

UNIT 2 WEAR **9**

Types of wear - Simple theory of Sliding Wear Mechanism - Abrasive wear - Materials for Adhesive and Abrasive wear situations.

Corrosive wear - Surface Fatigue wear situations-Brittle Fracture Wear -Wear of ceramics and polymers – Wear Measurements.

UNIT 3 LUBRICANTS AND LUBRICATION TYPES **9**

Types and properties of Lubricants – Lubricant additives – Lubricant impurities and contaminants- Testing methods

Hydrodynamic Lubrication - Elasto hydrodynamic lubrication- Boundary Lubrication – Solid Lubrication, Hydrostatic Lubrication.

UNIT 4 FILM LUBRICATION THEORY **9**

Coefficient of viscosity -Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation -Reynolds Equation for film lubrication.

High speed unloaded journal bearings - Loaded journal bearings - Reaction torque on the bearings - Virtual Co-efficient of friction - The Somerfield diagram.

UNIT 5 SURFACE ENGINEERING AND MATERIALS FOR BEARINGS **9**

Surface modifications – Transformation Hardening, surface fusion – Thermo chemical processes – Surface coatings – Plating and anodizing – Fusion Processes-Vapour Phase processes

Materials for rolling Element bearings – Materials for fluid film bearings – Materials for marginally lubricated and dry bearings (Qualitative treatment only). Introduction to Bio Tribology and Nano Tribology

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Majumdar, “Introduction of Tribology of bearings”, A.H. Wheeler Co, 2015.
2. BasuS.K, SenguptaS.N and Ahyja B.B, “Fundementals of Tribology”,PHI Learning(P) Ltd,NewDelhi, 2011.

REFERENCES:

1. Neale M.J (Editor), “The Tribology Handbook”, Newnes. Butter worth Heinemann, U.K., 2016.
2. Bharath Bhushan, “Introduction to Tribology”, John Wiley & Sons, 2013.
3. Gwidon Stachowiak, “Engineering Tribology”, Butterworth-Heinemann, 2016.

e-RESOURCES:

1. https://books.google.co.in/books?isbn=1420050478
2. s1.downloadmienphi.net/file/downloadfile9/195/1344905.pdf

21MEE17 **MACHINE DRAWING** **L T P C**
2 0 2 3

Preamble

Machine drawings are graphic representations of any part or any assembly of parts. All parts of this information is used for designing a part, manufacturing, machining and finishing and also in positioning correctly in the final assembly to obtain the desirable or predetermined performance. The information given

by the machine drawings is needed for setting tools, inspection and quality control, sales and service.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the concepts of machine drawing and codes of practice
2. Identify and explain the types of fits and tolerance.
3. Develop sectional views of fasteners, joints and couplings.
4. Develop assembly drawings of bearings and valves
5. Draw assembly of mechanical components and lathe machine parts.

UNIT 1 INDIAN STANDARD CODE OF PRACTICE FOR ENGINEERING DRAWING **5**

General principles of presentation- conventional representation of threaded part springs, gear and common features, abbreviations and symbols for use in technical drawings- conventions for sectioning and dimensioning.

UNIT 2 FITS AND TOLERANCES **5**

Types of fits – Types of tolerance – Representation of tolerance on drawing – Calculation of minimum and maximum clearances and allowances – Geometrical tolerance – Form and position tolerances – Symbols – Indicating geometrical tolerances on drawings – Introduction to selective assembly and Interchangeable manufacture.

UNIT 3 FASTENERS, JOINTS AND COUPLINGS **10**

Making free hand sketches of the following assemblies: Fasteners – square threaded nut and bolt – Hexagonal headed nut and bolt – cotter joint with sleeve – knuckle joint – Gib and cotter joint – couplings – protected and unprotected type flanged coupling.

UNIT 4 ASSEMBLY DRAWING **12**

Plummer block – Foot step ball bearing – Foot step journal bearing – Stop valve – Rams bottom safety valve.

UNIT 5 ASSEMBLY OF MACHINE PARTS **13**

Screw jack – Tailstock – Tool head of shaper – Machine vice – connecting rod. Study of blue print drawings.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Basudeb Bhattacharya, - Text book of Machine Drawing, Oxford University press, New Delhi,2013
2. GoelBK,GoelPK,Pemukhi MN- Machine Drawing, Kataria& sons, New Delhi 2011.

REFERENCES:

1. K. L. Narayana and P. Kannaiah, “Machine Drawing”, 3rd Edition, New Age International Publishers limited, New Delhi, 2014
2. K. C. John, “Text Book of Machine Drawing”, Pentice Hall of India, New Delhi, 2011.
3. N. D. Bhatt and V. M. Panchal . “Machine Drawing”, 45th Edition, Charotar Publishing House Pvt. Limited, Anand, Gujarat, 2011.

e-RESOURCES:

1. http://freevideolectures.com/Course/3420/Engineering-Drawing/13
   Dr. AnupamSaxena, IIT Kanpur,Engineering Drawing

21MEE21 **ADDITIVE MANUFACTURING** **L T P C**
3 0 0 3

Preamble:
Additive Manufacturing is a group of techniques used to quickly fabricate a scale model of a physical part or assembly using three-dimensional computer aided design (CAD) data. Construction of the part or assembly is usually done using 3D printing or "additive layer manufacturing" technology. Additive manufacturing improves product development by enabling better communication in a concurrent engineering environment and also reduces product development cycle time. This course aims to provide knowledge on the additive manufacturing and its application, advantages, limitations.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the basics of additive manufacturing techniques.
2. Discuss the concepts of CAD modelling, data processing and reverse engineering.
3. Apply the liquid and solid based additive manufacturing system for aerospace applications.
4. Explain the working principle of powder based additive manufacturing systems.
5. Analyze the characteristics of the rapid tooling techniques in additive manufacturing.

UNIT 1 ADDITIVE MANUFACTURING **9**

Definition of Prototypes, Roles of Prototypes, Need for time compression in product development, History of AM Process, classification of AM Process – Fundamentals of AM Process – Process chain of AM Process – Data format – STL files. Benefits of AM – Three Dimensional Printing.

UNIT 2 REVERSE ENGINEERING AND CAD MODELING **9**

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM.

UNIT 3 LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **9**

Stereo lithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, advantages, Limitations and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT 4 POWDER BASED ADDITIVE MANUFACTURING **9**

Selective Laser Sintering – Principles of SLS process – Process, advantages and applications, Laser Engineered Net Shaping (LENS) – Principle, process, advantages and applications- Electron Beam Melting - Principle, process, advantages and applications - Case studies.

UNIT 5 RAPID TOOLING AND APPLICATIONS OF ADDITIVE MANUFACTURING **9**

Classification of Rapid Tooling - Indirect rapid tooling - Silicone rubber tooling, Aluminium filled epoxy tooling, Spray metal tooling, Direct rapid tooling - Direct ACES Injection Moulding. Soft tooling vs hard tooling, Applications of AM in product design, automotive industry, medical field – Case studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2015.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.

REFERENCES:

1. Kamrani, Ali K., Nasr, EmadAbouel, "Rapid prototyping: Theory and Practice", Cambridge University Press, 2006.
2. Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.

e-RESOURCES:

1. https://nptel.ac.in/courses/112104204/47, Prof. ShantanuBattacharya, IIT Kanpur.
2. https://www.ge.com/additive/additive-manufacturing

21MEE22 **NON DESTRUCTIVE TESTING** **L T P C**
3 0 0 3

Preamble:
Non destructive testing (NDT) is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. Non destructive inspections ensure product integrity and reliability and to maintain a uniform quality level. This course aim to provide knowledge on the working, types, advantages, limitations, and applications of various NDT techniques.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the visual inspection process using the equipment, procedure and light sources for visual inspection.
2. Discuss the standards and techniques of liquid penetrant inspection and magnetic particle inspection using the testing stations, procedure and result interpretation for LPI and MPI.
3. Explain the thermography and eddy current testing process using the instrumentation and procedure for thermography and ECT.
4. Describe the ultrasonic wave generation using piezo electri effect and classify the data representation methods based on the concepts of A scan, B scan and C scan methods.
5. Explain the process of radiography testing using the equipment, types and procedure for radiography testing.

UNIT 1 DESTRUCTIVE TESTING METHODS AND VISUAL INSPECTION 9

Non destructive testing - Scope, Destructive methods of testing - Comparison between destructive and non destructive testing - Notable events - Common NDT Methods, Flaws and defects, Applications –Visual inspection – Aided and Unaided - Basic terms, Equipments used - Mirrors, magnifiers, boroscopes and fibroscopes – Light sources and special lighting, Machine vision - Chalk test - Visual inspection of welding defects.

UNIT 2 LIQUID PENETRANT AND MAGNETIC PARTICLE INSPECTION 9

Principle of penetrant testing - Tests and standards, test stations - Accessories - Illustrative examples - Types of penetrants, Penetrant application techniques - Characteristics of good penetrants - Developer and its types - Health and safety precautions in liquid penetrant inspection, Standards - Leak test- Testing Procedure and Interpretation of results. Generation of Magnetic fields – Magnetic particle inspection equipment –Interpretation and evaluation of test indications - Demagnetization – Applications and limitations.

UNIT 3 THERMOGRAPHY AND EDDY CURRENT TESTING 9

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals - Advantages and limitation – Infrared radiation and infrared detectors - Instrumentations and methods - Applications. Eddy Current Testing-Generation of eddy currents - Properties of eddy currents - Eddy current sensing elements - Probes - Instrumentation - Types of arrangement - Applications - Advantages - Limitations - Interpretation/Evaluation.

UNIT 4 ULTRASONIC TESTING AND ACOUSTIC EMISSION TESTING 9

Ultrasonic Testing- Piezo Electric Effect – Testing Principle, Transducers, Transmission and Pulse-echo method, Straight beam and Angle beam, Instrumentation, Data representation, A-scan, B-scan, C-scan. Phased array ultrasound, Time of flight diffraction. Acoustic emission technique -Principle, AE parameters, Applications.

UNIT 5 RADIOGRAPHY TESTING 9

Principle, Interaction of X-Ray with matter, Imaging, film and film less techniques - Types and Use of filters and screens - Geometric factors, Inverse square law, characteristics of films – graininess, density, speed, contrast, characteristic curves, penetrameters, exposure charts - Radiographic equivalence. Fluoroscopy - Xero - Radiography, Computed Radiography, Computed Tomography.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar and M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2011.
2. Barry Hull, “Non Destructive Testing”, Springer, 2012.

REFERENCES:

1. ASM Metals Handbook, on ”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, “Introduction to Non-destructive testing: A training guide”, Wiley, 2nd Edition, New Jersey, 2012.
3. J Prasad, C. G. Krishnadas Nair, “Non-Destructive Test and Evaluation of Materials”, 2nd Edition, McGraw Hill Education (India) Private Limited, 2011.
4. Charles, J. Hellier,“Handbook of Nondestructive evaluation”, 2nd Edition, McGraw-Hill Education,2013.

e-RESOURCES:

1. https://nptel.ac.in/courses/113/106/113106070/ Dr. Ranjit Bauri, IIT Madras, Theory and Practice of Non Destructive Testing.
2. https://www.udemy.com/course/ultrasonic-testing-level-1-training/ Mustapha benbihi, Virtus Veritas & Ingenium (VVI Ltd.), Ultrasonic Testing Level 1 Training.

21MEE23 UNCONVENTIONAL MACHINING PROCESSES L T P C
3 0 0 3

Preamble:
Unconventional manufacturing processes is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional manufacturing processes. This is a special type of machining process in which there is no direct contact between the tool and the workpiece. In unconventional machining, a form of energy is used to remove unwanted material from a given workpiece.

Course Outcomes: Upon completion of the course, students will be able to:

1. Select appropriate advanced materials process for a given product or component recognizing material, size, precision, and surface quality requirements.
2. Demonstrate the working principles and equipment of ultrasonic machining and abrasive jet machining.
3. Outline the fundamentals of EDM and wire cut EDM processes.
4. Illustrate the concepts of electrochemical processes.
5. Discuss about thermal energy processes.

UNIT 1 INTRODUCTION 9

Need for modern machining processes – Classification based on materials –Machining methods – Energy – Process selection. Physical parameters – Cost of production – Volume of production – Shapes of product – Process capability – Economical production.

UNIT 2 MECHANICAL ENERGY BASED PROCESSES 9

Abrasive jet machining, Water jet machining, Abrasive water jet machining, Ultrasonic machining – magneto rheological abrasive flow finishing – Working principles.

Tool feed mechanisms – Equipment used – Process parameters and its calculation – Material removal rate – Applications.

UNIT 3 ELECTRICAL ENERGY BASED PROCESSES 9

Electric discharge machining (EDM) – Working principle– Equipment description – Process parameters and its calculation –Surface finish and Material removal rate – Types of electrodes – Metallic, Non–metallic, Combined electrodes – Power and control circuits–Tool wear – Dielectric medium – Flushing techniques – Pressure flushing, Vacuum flushing, Side flushing, Electrical Discharge Wire Cut – Principle – Characteristics – Wire feed system – Advantages and Disadvantages – Applications.

UNIT 4 CHEMICAL AND ELECTROCHEMICAL ENERGY BASED PROCESSES 9

Chemical machining – Etchants, Maskant – Techniques of applying maskants, Process parameters, MRR – Applications. Electrochemical machining – Principles of ECM – Equipment, MRR, Electrical circuit, Process parameters, Electrostream drilling – Electrochemical grinding and Electrochemical honing – Applications.

UNIT 5 THERMAL ENERGY BASED PROCESSES 9

Laser beam machining (LBM) - Lasing materials, Equipment, Process parameters, Applications. Plasma arc machining (PAM) -Plasma torch, Transferred Arc mode, Non-transferred arc mode, Applications. Electron beam machining (EBM) – Principles, Equipment, Types, Beam control techniques, applications. Ion beam machining (IBM) – Principles, Equipment, applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Pandey P.C. and Shan H.S. “Modern Machining Processes” McGraw–Hill Education, New Delhi, 2013.
2. Jain, Vijay.K. “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2010.

REFERENCES:

1. Jagadeesha T, “Unconventional Machining Processes”, I K International Publishing House, 2016.
2. Rahul Jain, “Unconventional Machining Processes”, S.K. Kataria & Sons, Reprint, 2013.
3. Mikell P. Groover. “Fundamentals of Modern Manufacturing: Materials, Processes, and Systems” John Wiley & Sons, 2010.

e–RESOURCES:

1. http://nptel.ac.in/courses/112105127/pdf/LM–35.pdf , IIT Kharagpur, Non TraditionalManufacturing.
2. http://www.slideshare.net/RameshPanda2/introduction–2–64646738.

21MEE24 DIGITAL MANUFACTURING AND IoT L T P C
3 0 0 3

Preamble:
Digital manufacturing is the use of an integrated, computer-based system comprised of simulation, 3D visualization, analytics and collaboration tools to create product and manufacturing process definitions simultaneously.

Course Outcomes: Upon completion of the course, students will be able to:
1. Impart knowledge to use various elements in the digital manufacturing.
2. Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyse and optimize various practical manufacturing process through digital twin.

UNIT 1 INTRODUCTION 9

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing

UNIT 2 DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 9

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

UNIT 3 SMART FACTORY 9

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

UNIT 4 INDUSTRY 4.0 9

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

UNIT 5 STUDY OF DIGITAL TWIN 9

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow-Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.

REFERENCES:

1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.
3. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017

e-RESOURCES:
1. https://nptel.ac.in/courses/106105195
2. https://onlinecourses.nptel.ac.in/noc20_cs69/preview

21MEE25 **INDUSTRY 4.0** **L T P C**
3 0 0 3

Preamble:
The course concerns the transformation of industrial processes through the integration of modern technologies such as sensors, communication, and computational processing. Industry 4.0 is the digital transformation of manufacturing/production and related value creation processes. It deals with the current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems, Internet of Things (IoT), cloud computing and artificial intelligence in creating the smart factory.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the principles of Industry 4.0 by using the concepts and characteristics of Industry 4.0.
2. Identify the drivers for developing the Industry 4.0 and impact of Industry 4.0 in various level of community.
3. Explain the basics and needs of Industrial Internet in an Industry based on principles and needs.
4. Describe the transformation of an Industry to Industry 4.0 by the customer experiences and feedbacks.
5. Apply the smartness based on I4.0 in smart factories, smart products and smart services

UNIT 1 INDUSTRY 4.0 **9**

Defining Industry 4.0 – Need for Industry 4.0 - Four Main Characteristics of Industry 4.0 - The Value Chain - Creating a Value Chain, Differential Prospective, Cost Differential, Benefits to Business - Industry 4.0 Design Principles - Building Blocks of Industry 4.0.

UNIT 2 DRIVERS AND IMPACT OF I4.0 **9**

Megatrends – Physical – Digital – Biological - Economy – Growth, Employment, The Nature of Work - The Individual - Identity, Morality and Ethics, Human Connection, Managing Public and Private Information – Society -Inequality and the Middle Class, Community.

UNIT 3 BASICS OF INDUSTRIAL INTERNET **9**

Industrial Internet - The Power of 1% - Key IIoT Technologies – Need for Industrial Internet - Catalysts and Precursors of the IIoT - Adequately Skilled and Trained Staff, Commitment to Innovation, Strong Security Team - Innovation and the IIoT - Intelligent Devices - Key Opportunities and Benefits - The Why Behind the Buy - Selling Light, Not Light Bulbs - The Digital and Human Workforce.

UNIT 4 TRANSFORMATION OF I4.0 **9**

Digital Transformation - Customer Experience - Knowing the Customer, Customer Contact Points - Transforming Operational Processes - Transforming Business Models - Increase Operational Efficiency - Adopt Smart Architectures and Technologies - Transform the Workforce.

UNIT 5 SMART FACTORIES **9**

Introduction to the Smart Factory - Smart Factories in Action – Importance of Smart Manufacturing - Winners and Losers – Real World Smart Factories - GE's Brilliant Factory, From App to Production, Airbus: Smart Tools and Smart Apps - Siemens' Amberg Electronics Plant.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st Edition, Springer - Apress, 2016.
2. Klaus Schwab, "The fourth industrial revolution", 1st Edition, World Economic Forum, Geneva, Switzerland, 2016

REFERENCES:

1. Mohammad Dastbaz , Peter Cochrane "Industry 4.0 and Engineering for a Sustainable Future" Springer ISBN 978-3-030-12953-8- 2019.
2. Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz "Industry 4.0: Industrial Revolution of the 21st Century" Springer,2018
3. Kaushik Kumar, Divya Zindani, J. Paulo Davim, "Digital Manufacturing and Assembly Systems in Industry 4.0", CRC Press, 2019.

e-RESOURCES:

1. https://www.ge.com/digital/applications/manufacturing-execution-systems
2. http://www.airbusgroup.com/int/en/story-overview/factory-of- the-future.html
3. https://onlinecourses.nptel.ac.in/noc19_cs32/preview, Introduction to Industry 4.0 and Industrial Internet of Things, Dr. Sudip Misra, Indian Institute of Technology Kharagpur.

21MEE26 FLEXIBLE MANUFACTURING SYSTEMS L T P C
3 0 0 3

Preamble:
A flexible manufacturing system (FMS) is a production method that is designed to easily adapt to changes in the type and quantity of the product being manufactured. Machines and computerized systems can be configured to manufacture a variety of parts and handle changing levels of production.

Course Outcomes: Upon completion of the course, students will be able to:
1. Apply the concepts of PPC and GT to the development of FMS.
2. Discuss the planning and scheduling methods used in manufacturing systems
3. Identify various workstations, system support equipments.
4. Identify hardware and software components of FMS.
5. Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

UNIT 1 INTRODUCTION TO FMS AND GROUP TECHNOLOGY 9

Types of production, production planning and control, manufacturing in a competitive environment, concept, automation of manufacturing process , numerical control, adaptive control, material handling and movement, industrial robots, flexible fixturing, design for assembly, disassembly and service. types of FMS, types of FMS layouts, advantages and disadvantages of FMS Group technology – composite part families - classification and coding - production flow analysis,

UNIT 2 FUNCTIONS OF FMS 9

Planning issues: components of FMS, types of flexibility, tradeoffs, computer control and functions, planning, scheduling and control of FMS, scheduling and knowledge-based scheduling. Hierarchy of computer control, supervisory computer, introduction to turning center, machining center, cleaning and deburring equipment, coordinate measuring machines: types, working and capabilities.

UNIT 3 WORKSTATIONS AND SYSTEM SUPPORT EQUIPMENTS 9

System support equipment, types, working capability, automated material movement and automated storage and retrieval systems, scheduling of AGVs, cutting tools and tool management, work holding
Considerations.

UNIT 4 COMPONENTS OF FMS 9

FMS computer hardware and software, general structure and requirements, PLCs, FMS installation and implementation, acceptance testing

UNIT 5 CONCEPTS OF MODERN MANUFACTURING 9

Characteristics of JIT pull method, small lot sizes, work station loads, flexible work force, line flow strategy. supply chain management Preventive maintenance - Kanban system, value engineering, MRD JIT, lean manufacture, quality concepts and management

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Shivanand H.K., Benal MM, Koti V, “Flexible Manufacturing System”, New age international (P) Limited, New Delhi, 2006
2. Mikell P. Groover “Automation, Production Systems and Computer Integrated Manufacturing", PHI, 2008.

REFERENCES:

1. Kalpakjin, “Manufacturing Engineering and Technology ", Addison- Wesley Publishing Co., 1995.
2. Jha, N.K. “Handbook of flexible manufacturing systems”, Academic Press Inc., 1991.
3. Raouf, A. and Ben-Daya, M., Editors, “Flexible manufacturing systems: recent development”, Elsevier Science, 1995.

e-RESOURCES:
1. https://www.youtube.com/watch?v=YoslM2Sxihs
2. https://freevideolectures.com/course/3068/manufacturing-systems-management/37

21MEE27 ADVANCED CASTING AND WELDING PROCESSES L T P C
3 0 0 3

Preamble:
This course is intended to introduce the characteristic features of casting and welding processes. Process characteristics, analysis, and design criteria of various casting and welding processes will be discussed in detail with examples and video clips from industries.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding standards and codes.

UNIT 1 FERROUS CAST ALLOYS 9

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size-Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure-Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons-family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels- melting procedure and composition control for carbon steels- low alloy steels - stainless steels- composition control- slag-metal reactions-desulphurization - dephosphorization, specifications for carbon steels- low alloy steels and stainless steels

UNIT 2 NON-FERROUS CAST ALLOYS 9

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys-problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

UNIT 3 PHYSICAL METALLURGY OF WELDING 9

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT 4 WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

UNIT 5 DEFECTS, WELDABILITY AND STANDARDS 9

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Hein e R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.
2. A.K. Chakrabarthi, ‘Casting Technology and Cast Alloys,Prentice Hall, 2005.

REFERENCES:

1. AS M International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International,2008.
2. Ba ldev Raj, Shankar V, Bhaduri A K, “Welding Technology for Engineers”, Narosa Publications, 2009.
3. Be eley P, “Foundry Technology" Butterworth-Heinemann, 2001.

e-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_me100/preview
2. https://archive.nptel.ac.in/courses/112/104/112104301/

21MEE31 LEAN MANUFACTURING AND SIX SIGMA L T P C
3 0 0 3

Preamble:
Lean manufacturing is a manufacturing philosophy that aims at eliminating the wastes in the processes, thereby making the processes more efficient, fast and utilizes optimum resources. Six sigma helps to reduce the variations in the processes. This course introduces the concepts, tools and implementation of lean manufacturing and six sigma.

Course Outcomes: Upon completion of the course, students will be able to:

1. Classify the wastes in production processes and explain the ways for waste elimination and value creation using the principles and rules of lean manufacturing.
2. Apply the appropriate lean primary tools for a particular situation based on the concepts of primary tools of lean maufacturing.
3. Classify the lean secondary tools and establish a continuous flow pull manufacturing environment using line balancing, JIT and Kanban.
4. Explain the six sigma implementation process using DMAIC methodology.
5. Describe the synergy effect of lean with other paradigms based on the principles of lean six sigma, lean enabled sustainability and leagile manufacturing.

UNIT 1 PRINCIPLES AND IMPLICATIONS OF LEAN AND OTHER MANUFACTURING PARADIGMS 9

Objectives of lean manufacturing- Lean Principles : Flow, pull, value, value stream and perfection – Implications of lean manufacturing – Rules of Lean Manufacturing – Comparison among craft, mass and lean manufacturing –Study of Ford and Toyota production systems - Types of activities – Seven basic types of wastes – Value creation and waste elimination.

UNIT 2 PRIMARY TOOLS OF LEAN MANUFACTURING 9

Primary tools of lean manufacturing – Standard work, 5S, Process Mapping and Value Stream Mapping, Work Cells.

Total productive maintenance – Principle, Hidden factory, The six big losses, Types of maintenance,Procedural steps and Advantages – Case studies on applications of 5S and VSM.

UNIT 3 SECONDARY TOOLS OF LEAN MANUFACTURING 9

Introduction to secondary tools of lean manufacturing – Ishikawa diagram, Pokayoke, Radar chart, SMED, Line balancing, Jidoka, Andon and Kaizen.

JIT– Definition – Principles of JIT: Continuous flow and Pull – JIT system – Kanban – Six Kanban rules – Design of Kanban quantities–Constant work in process pull alternative (CONWIP) - Production leveling – Three types of pull systems.

UNIT 4 SIX SIGMA 9

Six Sigma – Definition, Statistical considerations, variability reduction, Design of experiments – Six Sigma implementation: DMAIC cycle–Quality Function Deployment or House of Quality (QFD)– Failure Mode Effect Analysis –FMEA Process and Risk Priority Number (RPN).

Transactional vs. Manufacturing Six Sigma – Common terms, Foundations of lean Six Sigma – The four keys, five laws of lean Six Sigma.

UNIT 5 IMPLEMENTING LEAN AND RECONCILING LEAN WITH OTHER SYSTEMS 9

Implementing Lean: Road map – Senior management Involvement– Best practices – Leanness assessment– Indicators and methods for assessing leanness.

Introduction to lean integrated with other systems: Lean six sigma – Lean and ERP – Leagile manufacturing – Lean enabled sustainability - Administrative lean.

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., 2012.
2. Lonnie Wilson, “How To Implement Lean Manufacturing”, McGraw Hill Educations, 2010.

REFERENCES:

1. Yasuhiro Monden, “Toyota production system: An integrated approach to JIT”, CRC Press, 2012.
2. Niaz Ahmed Siddiqui,”Introduction to Six Sigma”, New Age International Publishers, 2016.
3. N.Gopalakrishnan, “Simplified Lean Manufacture: Element, Rules, Tools & Implementation”, PHI, 2010.

e-RESOURCES:

1. http://nptel.ac.in/courses/110105039/ Prof. Dr. T. P. Bagchi, IIT Kharagpur, Concepts in Quality Management.
2. https://www.coursera.org/learn/model-thinking/lecture/0FKHY/six-sigma, Scott E.Page, University of Michigan, Six Sigma.

21MEE32 **PLANT LAYOUT AND MATERIAL HANDLING** **L T P C**
3 0 0 3

Preamble:
The term Plant layout is mainly used to represent the physical arrangement of a plant and different parts of a plant. The arrangement of machines, equipments and other industrial facilities like receiving and shipping departments, tool rooms, maintenance rooms and employee amenities which helps in attaining rapid and interrupted flow of production activities at minimum cost is usually referred to as plant layout

Course Outcomes: Upon completion of the course, students will be able to:
1. Identify equipment requirements for a specific process and for various locations and Working conditions.
2. Design an efficient plant layout system for various engineering industry.
3. Understand the various manual material handling systems with specific operation.
4. Discuss the lifting tackles for material handling in mechanical based industry.
5. Illustrate the mechanical material handling systems.

UNIT 1 PLANT LOCATION AND WORKING CONDITIONS 10

Selection of plant locations - Territorial parameters - Considerations of land, water, electricity, location for waste treatment and disposal, further expansions -Safe location of chemical storages in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine – Explosives and propellants.

Principles of good ventilation – purpose - physiological and comfort level types - Local and exhaust - Ventilation, hood and duct design - Air conditioning - Ventilation standards - Application. Purpose of lighting - Types - Advantages of good illumination, glare and its effect, lighting requirements for various work, standards.

UNIT 2 PLANT LAYOUT 9

Safe layout, equipment layout - safety system - Fire hydrant locations, Fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plan trail way lines, security towers. Safe layout for process industries, Engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.

UNIT 3 MANUAL MATERIAL HANDLING 9

Preventing common injuries - Lifting by hand - Team lifting and carrying - Handling specific shape machines and other heavy objects – Accessories for manual handling - Hand tools, jacks, hand trucks, dollies and wheel barrows – Storage of specific materials - Problems with hazardous materials, liquids, solids – Storage and handling of cryogenic liquids- Shipping and receiving, stock picking, duckboards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – Personal protection – Ergonomic considerations.

UNIT 4 LIFTING TACKLES 8

Fiber rope - Types, strength and working load inspection, Rope in use, Rope in storage - Wire rope, construction, Design factors, Deterioration causes - Sheaves and Drums - Lubrication, Overloading, Rope fitting, Inspection and Replacement – Slings, Types, Method of attachment, Rated capacities, Alloy chain slings, Hooks and attachment, Inspection.

UNIT 5 MECHANICAL MATERIAL HANDLING 9

Hoisting apparatus - Types - Cranes, types - Design and construction, Guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications.

Powered industrial trucks - Requirements, Operating principles, Operators selection and training and performance test, Inspection and maintenance, Electric trucks - Gasoline operated trucks, LPG trucks – power elevators - Types of drives, hoist way and Machine room emergency procedure, requirements for the handicapped, Types- Escalator, safety devices and Brakes, Moving walks – Man lifts - Construction, brakes, Inspection.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Apple.M. James "Plant layout and material handling", 3rd edition, Krieger Publication, Malabar1991
2. G. K. Agarwal. 'Plant layout & material handling', Jain Brothers.2012

REFERENCES:

1. M.I. Khan, 'Industrial Engineering' New age international –New Delhi, 2012
2. R.B. Choudhary and G.R.N. Tagore,'Plant Layout and Materials Handling' Khanna publishers 2nd Edition.
3. S.C. Sharma.'Plant Layout and Materials Handling',3rd edition , Khanna publishers 2016

e-RESOURCES:

1. http://nptel.ac.in/courses/112107143/32
   Prof.InderdeepSingh, Department of Mechanical Engineering,IITRoorkee.
2. http://www.managementstudyguide.com/material-handling.htm

21MEE33 PROCESS PLANNING AND COST ESTIMATION L T P C
3 0 0 3

Preamble:
Process Planning and Cost Estimation course deals with concepts of process planning activities and impart the knowledge on cost estimation for various products after process planning.

Course Outcomes: Upon completion of the course, students will be able to:

1. Apply the knowledge on the work study and ergonomics concepts to implement in the workplace and design of tools and equipment.
2. Explain the scope and activities of process planning.
3. Classify the types of cost in the development of product.
4. Estimate the costs of forging, welding and casting process to make or buy the product.
5. Estimate the machining time required for lathe operations, shaping, planning and slotting operations for the manufacture of component.

UNIT 1 WORK STUDY AND ERGONOMICS 9

Method study – Definition, Objectives, Procedure, Tools and techniques - Principles of motion economy. Work measurements – Definition, Purpose, Techniques.

Time Study – Basic study, Allowances. Ergonomics – Principles, Importance, Applications.

UNIT 2 PROCESS PLANNING ACTIVITIES 9

Process Planning - Methods of Process Planning - Drawing Interpretation - Material Evaluation - Steps in Process Selection - Production Equipment and Tooling Selection.

Process parameters calculation for various production processes - Selection of jigs and fixtures - Set of documents for process planning.

UNIT 3 COST ESTIMATION 9

Objective of cost estimation- Costing – Cost accounting- Classification of cost- Elements of cost- Types of estimates – Estimating procedure- Estimation of labor cost, Material cost- Allocation of overhead charges- Calculation of depreciation cost- allowances in estimation.

UNIT 4 ESTIMATION OF COSTS IN DIFFERENT SHOPS 9

Estimation of forging shop – Types of forging processes –Material losses estimation, Forging cost estimation. Estimation of welding shop - Gas welding and Electric arc welding cost estimation-Illustrative examples.

Estimation of foundry shop –Pattern allowances, Pattern cost estimation, Casting cost estimation-Illustrative examples.

UNIT 5 ESTIMATION OF MACHINING TIME 9

Importance of Machining time calculation, Estimation of machining time for lathe operations – Turning, Chamfering, Facing, Knurling, Drilling, Boring, Taper Turning-Illustrative examples.

Estimation of machining time for Shaping, Planning and Slotting operations- Illustrative examples.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Panneerselvam. R and Sivasankaran. P, “Process Planning and Cost Estimation”, PHI Learning, 2016.
2. Khanna. O.P, “A Text-Book of Mechanical Estimating & Costing”, Khanna Publishers, New Delhi, 2013.

REFERENCES:

1. Khanna. R.B, "Production and operations management", 2nd Edition, PHI Learning, 2015.
2. Adithan.M, “Process Planning and Cost Estimation”, 2nd Edition, New Age International Publisher, 2013.
3. Banga. T.R, Sharma. S.C, “Mechanical Estimating and Costing”, 16th Edition, Khanna Publishers, 2015.

e-RESOURCES:

1. www.onlinevideolecture.com/?course_id=557&lecture_no=1
2. www.study.com/academy/lesson/what-is-the-planning-process-steps-lesson-quiz.html

21MEE34 **SUPPLY CHAIN MANAGEMENT** **L T P C**
3 0 0 3

Preamble:
The supply chain consists of all the steps which lead to the production of goods and services, including suppliers and distribution channels. This course is mainly concerned about the right amount of the right goods and services are delivered to customers at the right time that must coordinate the links of the supply chain to maintain quality and customer satisfaction, while at the same time keeping costs under control.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the importance of supply chain management.
2. Apply the forecasting techniques to improve the facility and network design.
3. Classify the techniques of inventory management.
4. Describe the design and planning methods in transportation networks.
5. Discuss the importance of supply chain in information technology field.

UNIT 1 EVOLUTION AND SUPPLY CHAIN PERFORMANCE **8**

Supply Chain – Historical perspective – objective of a supply chain – Importance – Decision phases – process views of supply chain. Supply Chain Strategy – Supply Chain performance Measures: competitive and supply chain strategies – achieving strategic fit – expanding strategic scope – challenges to achieving and maintaining strategic fit.

UNIT 2 PLANNING THE SUPPLY CHAIN **9**

Demand Forecasting in supply chain – characteristic of forecast – components of a forecast and forecasting methods- basic approach to demand forecasting – Time series forecasting – measures of forecasting error – selecting the best smoothing constant – forecasting demand at Tahoe salt – The role of IT in forecasting.

UNIT 3 INVENTORY MANAGEMENT **9**

Role of cycle Inventory in a supply chain – Estimating cycle inventory cost in practice – economics of scale to exploit fixed – economics of scale to Exploit Fixed costs – Aggregating Multiple Products in a Single order – Economics of Scale to Exploit quantity discounts – short term discounting: trade promotions – Managing Multiechelon cycle inventory – role of safety inventory in a supply chain - The role of Radio-Frequency Identification in supply chain management

UNIT 4 DESIGNING AND PLANNING TRANSPORTATION NETWORKS **10**

Role of Transportation in a Supply Chain – Modes of Transportation and their Performance Characteristics – Transportation Infrastructure and Policies – Design options for a Transportation Network – Mumbai Dabbawalas: A highly Responsive Distribution network – Trade-offs in Transportation – Tailored Transportation – Role of IT in Transportation

UNIT 5 SUPPLY CHAIN AND INFORMATION TECHNOLOGY **9**

The Role IT in Supply Chain - The Supply Chain IT Framework - Customer Relationship Management – Internal Supply Chain Management – Supplier Relationship management – The Transaction Management Foundation - Future of IT in Supply Chain.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and operation", Pearson Education, 6th edition, 2018.
2. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies, and Cases", Tata McGraw-Hill, 2005.

REFERENCES:

1. Dimitris N. Chorafas , "Integrating Erp, Crm, Supply Chain Management, and Smart Materials", Auerbach, 2001
2. Donald Waters, "Logistics An Introduction to Supply Chain Management", Palgrave Macmillan, 2003
3. Michael H. Hugos, "Essentials of supply chain management", John Wiley, 2006

e-RESOURCES:

1. https://nptel.ac.in/courses/110105083/18
2. https://nptel.ac.in/courses/110107074/1

21MEE35 INDUSTRIAL SAFETY ENGINEERING L T P C
3 0 0 3

Preamble:
This course provides an introduction to safety management, accident investigation and reporting; it also provides an hazards in industries and also offers safety and operational precautions implemented in metal working machinery, hot and cold working industry.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the functions and activities of safety engineering department.
2. Carry out accident investigation, analysis and reporting.
3. Illustrate the use of critical thinking to identify and assess hazards in industries.
4. Discuss the use of Safety rules in metal working industry.
5. Explain about the safety measures to be implemented in cold, hot working of metals and metal working machinery industry.

UNIT 1 SAFETY MANAGEMENT 9

Evaluation of modern safety concepts - Safety management functions - Safety department – Safety committee, Safety audit - Performance measurements and motivation – Employee participation in safety - Safety and productivity - Introduction to Ergonomics.

UNIT 2 ACCIDENT INVESTIGATION AND REPORTING 9

Concept of an accident - Reportable and non-reportable accidents, Reporting to statutory authorities – Principles of accident prevention – Accident investigation and analysis – Records for accidents, Departmental accident reports, Documentation of accidents – Unsafe act and condition – Supervisory role – Role of safety committee – Cost of accident.

UNIT 3 HAZARDS IN INDUSTRIES 9

Hazard - Classification - Chemical, physical, mechanical, ergonomic, biological hazards - Hazard evaluation techniques - Engineering control of hazards and accidents due to fire explosions in industries – Fertilizers - Petroleum refinery - Fault tree analysis – Event tree analysis – Failure modes and effect analysis – Past accident analysis - Hierarchy of hazard control -Health and Hygiene management system in Industrial Environment – Occupational hazards.

UNIT 4 SAFETY IN METAL WORKING MACHINERY 9

General safety rules- principles- maintenance- inspection of turning machines- boring machines- milling machines- planning machines- grinding machines- CNC machines- shaping machines- drilling machines.

UNIT 5 SAFETY IN COLD AND HOT WORKING OF METALS 9

cold working: power presses- point of operation safe guarding – auxiliary mechanisms- feeding and cutting mechanism- hand or foot operated presses- power press setup and die removal- inspection and maintenance. Metal shears- hot working: safety in forging, hot rolling mill operation- safe guards in hot rolling mills- hot bending pipes- foundry: health hazards and safety measures.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. C. Ray Asfahl and David W.Rieske, “Industrial safety and Health Management”, Prentice Hall Inc., NewYork, 2010.
2. Krishnan N.V., ―Safety in Industry‖, 1st Edition, Jaico Publishing House, 1996.

REFERENCES:

1. R.K.Mishra, “Safety Management”, AITBS Publishers India, 2012.
2. Blake R.P., ―Industrial Safety‖, 3rd Edition, Prentice Hall, New Jersey, 2006.
3. Jane Bluent, Nigel and Balchin C., ―Health and Safety in Welding and Allied Processes‖, 5th Edition, Wood Head Publishing, 2002.

e-RESOURCES:

1. http://nptel.ac.in/courses/112107143/40
   Prof. Inderdeep Singh, IIT Roorkee, Industrial Safety
2. https://www.nsai.ie/getattachment/Our-Services/Certification/Management-Systems/OHSAS-18001/MD-19-02-Rev-4--OHSAS-18001-Occupational-Health-and-Safety.pdf.aspx

21MEE36 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

Preamble:
Operations Research is a scientific approach to decision making that leads to best design and operate a system, usually under the conditions requiring the allocation of limited resources. This course deals with the approaches to model physical problems and their planning environments and also to identify solutions to the simplified or approximated problems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Formulate Engineering and business problems as LP problems and solve using simplex, Big M and Two Phase methods.
2. Solve transportation and assignment problems using MODI method and Hungarian algorithm.
3. Perform network analysis using PERT and CPM techniques.
4. Model queuing problems as Poisson arrival and exponential service models and calculate the queue length and waiting time.
5. Explain nontraditional optimization techniques using the concepts of Genetic algorithm and Ant colony optimization.

UNIT 1 LINEAR MODELS **9**

Operations research-Definition - Phases - Models, Linear Programming problems formulation – Graphical method – Simplex methods.

Big M, Two phase methods - Alternate optimal solutions.

UNIT 2 TRANSPORTATION AND ASSIGNMENT MODELS **9**

Transportation model – Initial solution by North West corner method – Least Cost method – VAM. Optimality test – MODI method.

Assignment model – Formulation – Balanced and unbalanced assignment problems - Hungarian algorithm - Traveling Salesman problem.

UNIT 3 PROJECT NETWORK ANALYSIS, LINE BALANCING AND DECISION TREE ANALYSIS **9**

Project network – CPM and PERT networks –Critical path scheduling – Crashing of network.

Line balancing – Applications. Decision tree analysis – Applications.

UNIT 4 INVENTORY AND QUEUING MODELS **9**

Inventory models – Economic order quantity models – Quantity discount models

Elements of queue – queue discipline – Poisson arrival and exponential service – queue length – waiting time – steady state conditions – applications.

UNIT 5 REPLACEMENT MODELS AND NON TRADITIONAL TECHNIQUES **9**

Replacement Analysis - Types of replacement problem - Replacement of item that fail with respect to time - Replacement of item that fail suddenly-Individual replacement and group replacement.

Introduction to Non traditional techniques – Genetic algorithm and Ant colony optimization (Qualitative Treatment Only).

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gupta and Hira, “Problems in Operations Research”, S Chand and Company, New Delhi, 2011.
2. Hamdy ATaha, “Operations Research an Introduction”, 9th Edition, PHI/Pearson Education, 2011.

REFERENCES:

1. Tulsian and Pasdey V., “Quantitative Techniques”, Pearson Asia, 2013.
2. J.K.Sharma, “Operations Research: Theory and Applications” 5th Edition, Laxmi Publications, New Delhi, 2014.
3. Dharani Venkatakrishnan.S, “Operations Research”, Keerthi Publication House, Coimbatore, 2011.
4. R.Pannerselvam, “Operations Research”, 2nd Edition, PHI, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/112106134/ Prof. G. Srinivasan/ Operations Research/ Indian Institute of Technology, Madras.
2. http://nptel.ac.in/courses/112106131/ Prof. G. Srinivasan/ Operations Research/ Indian Institute of Technology, Madras.

21MEE37 QUALITY CONTROL AND RELIABILITY ENGINEERING L T P C
3 0 0 3

Preamble:
Quality and reliability engineering seeks to ensure acceptable outcomes and reduce process failure in manufacturing and other systems. Quality and reliability engineering technique are widely used as improvement tools in manufacturing industries, involving the design experiments.

Course Outcomes: Upon completion of the course, students will be able to:

1. Summarize the concept of Quality and Process control for variables
2. Apply the process control for attributes
3. Explain the concept of sampling and to solve problems
4. Explain the concept of Life testing
5. Explain the concept Reliability and techniques involved

UNIT 1 INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart –X chart, R chart and - process capability - process capability studies and simple problems. Six sigma concepts

UNIT 2 PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non conformings– p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT 3 ACCEPTANCE SAMPLING 9

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT 4 LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT 5 QUALITY AND RELIABLITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development–Product life cycles.

TOTAL: 45 PERIODS

Use of approved statistical table permitted in the examination.

TEXT BOOKS:

1. Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th edition, John Wiley 2012.
2. Srinath. L.S., "Reliability Engineering", Affiliated East west press, 2008.

REFERENCES:

1. Besterfield D.H., "Quality Control", Prentice Hall, 2013.
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012
3. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 2017

e-RESOURCES:

1. https://nptel.ac.in/courses/110105088
2. https://onlinecourses.nptel.ac.in/noc23_ge20/preview

21MEE41 **MAINTENANCE ENGINEERING** **L T P C**
3 0 0 3

Preamble:
Maintenance Engineering course enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities, to explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements and to illustrate some of the simple instruments used for condition monitoring in industry.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the maintenance activities in industry and build successful management for maintenance activities.
2. Explain the maintenance strategies and the process of achieving them in various industry sectors.
3. Describe the condition monitoring methods and instruments for monitoring vibration, temperature, lubrication, corrosion and leakage.
4. Identify and explain the repair methods for lathe beds, slideways, spindles, gears and bearings.
5. Identify and explain the repair methods for material handling equipments like conveyors, elevators, fork truck and cranes.

UNIT 1 PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING **9**

Introduction to repair and maintenance - Objectives and principles of planned maintenance activity - Importance and benefits of sound Maintenance systems - Reliability and machine availability - MTBF, MTTR and MWT -Factors of availability - Maintenance organization - Maintenance economics.

UNIT 2 MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE **9**

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

UNIT 3 CONDITION MONITORING **9**

Condition Monitoring (CM) - Cost comparison with and without CM - On-load testing and offload testing - Methods and instruments for CM - Visual, Vibration, Temperature, Lubrication, Corrosion, Leakage monitoring.

UNIT 4 REPAIR METHODS FOR BASIC MACHINE ELEMENTS **9**

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

UNIT 5 REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT **9**

Repair methods for Material handling equipment - Conveyors, Elevators, Fork truck, Cranes - Equipment records - Job order systems - Use of computers in maintenance.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Srivastava S.K., “Maintenance Engineering & Management”, - S. Chand and Co., 2012
2. Venkataraman K., “Maintenance Engineering & Management”, PHI Learning, Pvt. Ltd., 2015.

REFERENCES:

1. Garg H.P., "Industrial Maintenance", S. Chand & Co., 1st Edition, 2010.
2. Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill Education (India) Pvt. Ltd, 8th Edition, 2014.
3. R.C.Mishra, “Maintenance Engineering and management “, PHI Learning, 2012.

e-RESOURCES:

1. http://nptel.ac.in/courses/112107142/24 Prof. H.S.Shan, IIT Roorkee, Industrial Engineering.
2. http://webcache.googleusercontent.com/search?q=cache:http://nptel.ac.in/courses/112105048/1&gws_rd=cr&ei=uHGhWO3dCIHkvgTy2ZvYAw
   Prof.A R. Mohanty. IIT Kharagpur, Machinery Fault Diagnosis and Signal Processing.

21MEE42 PRODUCT LIFECYCLE MANAGEMENT L T P C
3 0 0 3

Preamble:
Product lifecycle management (PLM) refers to the handling of a good as it moves through the typical stages of its product life development and introduction, growth, maturity/stability, and decline. This handling involves both the manufacturing of the good and the marketing of it. The concept of product life cycle helps inform business decision-making, from pricing and promotion to expansion or cost-cutting.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain history, concepts and terminology of PLM.
2. Apply the functions and features of PLM/PDM.
3. Summarize different modules offered in commercial PLM/PDM tools.
4. Illustrate PLM/PDM implementation approaches.
5. Integrate PLM/PDM with other applications.

UNIT 1 HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to 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) – Product Lifecycle Management (PLM).

PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT 2 PLM/PDM FUNCTIONS AND FEATURES 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 3 ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, 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, organisation, users, product or service, process performance.

UNIT 4 BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP.

Case studies based on top few commercial PLM/PDM tools (not for examination).

UNIT 5 LIFE CYCLE ASSESSMENT AND LIFE CYCLE COST ANALYSIS 9

Properties and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis, Case Studies in LCA and LCCA.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006.
2. Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition).

REFERENCES:

1. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.
2. John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.
3. Karl Ulrich, Steven Eppinger, "Product Design and Development",McGraw Hill Education, 2008.

e-RESOURCES:

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/106105195/lec12.
2. https://nptel.ac.in/courses/110/104/110104084/
   Prof. Jayanta chatterjee, IIT Kanpur, Product lifecycle and chasm.

21MEE43 PRINCIPLES OF MANAGEMENT L T P C
3 0 0 3

Preamble:
Management is essential to any organization that wishes to be efficient and achieve its aims. It is pertinent to emphasize that the principles of management are the essential, underlying factors that form the foundations of successful management.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the principles of management and administration.
2. Explain the concepts of planning, organizing and controlling for managerial actions.
3. Identify and explain the management principles into practices.
4. Discuss the various functions of management to improve productivity.
5. Demonstrate knowledge on international aspect of management.

UNIT 1 INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - Types of managers -Managerial roles and skills – Evolution of classical, behavioral and contemporary management thoughts – Types of business organization - Sole proprietorship, partnership, Company-public and private sector enterprises – Current trends and issues in management.

UNIT 2 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 3 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.

UNIT 4 DIRECTING 9

Foundations of individual and group behavior – Motivation – Maslow's Hierarchy and Herzberg's theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – Types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication.

UNIT 5 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.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Stephen P. Robbins, David A Decenzo and Sanghamitra Bhattacharyya "Fundamentals of Management", Pearson Education – New Delhi , 2015.
2. Tripathy PC & Reddy PN, "Principles of Management",Mcgraw Hill Education, 2013.

REFERENCES:

1. Harold Koontz & Heinz Weihrich, "Essentials of Management", McGraw Hill Education, 2012.
2. James AF Stoner, Edward Ferrman R and Daniel R Gilbert "Management", 6th Edition, Pearson Education – New Delhi, 2013.
3. Harold Koontz, Heinz Weihrich and Ramachandra Aryasri A, "Principles of Management", Mcgraw Hill Education, 2011.

e-RESOURCES:

1. http://nptel.ac.in/courses/110105069/ Prof. Aradhana Malik, IIT Kharagpur, Principles of Human Resource Management.
2. http://nptel.ac.in/courses/110102016/ Prof. Vinayshil Gautam, Department of management studies, IIT Delhi, Organisation Management.

21MEE44 ENGINEERING ECONOMICS AND PROJECT MANAGEMENT L T P C
3 0 0 3

Preamble:
Engineering Economics which deals with the methods that enable one to make economic decisions towards minimizing costs and or maximizing benefits to business organizations. The economic decisions which will help in minimizing investment, operating and maintenance expenditures besides increasing the revenue, savings and such other gains of the organization.

Course Outcomes: Upon completion of the course, students will be able to:

1. Apply knowledge of mathematics, economics, and engineering principles to solve engineering problems.
2. Determine the ability to account for time value of money using engineering economy factors and formulas
3. Explain the major capabilities and limitations of cash flow analysis for evaluating proposed capital investments
4. Analyze the replacement of an asset with a new asset using individual or group replacement methods.
5. Identify the depreciation and suggest suitable alternatives using depreciation methods.

UNIT 1 BASICS OF ECONOMICS 9

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of Engineering economics - Element of costs - Marginal cost, Marginal revenue, Sunk cost and Opportunity cost.

Break-even analysis -PV ratio, Elementary economic analysis – Material selection for product, Design selection for a product.

UNIT 2 VALUE ENGINEERING 9

Value Engineering – Function, Aims, Value Engineering procedure. Make or buy decision- Economic analysis.

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 payment present worth factor - Equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate.

UNIT 3 CASH FLOW ANALYSIS 9

Methods of comparison of alternatives – Present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram).

UNIT 4 REPLACEMENT AND MAINTENANCE ANALYSIS 9

Replacement and Maintenance analysis – Types of maintenance, Types of 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 5 DEPRECIATION AND PROJECT MANAGEMENT 9

Depreciation - Introduction, Straight line method of depreciation, Declining balance method of depreciation - Sum of the years digits method of depreciation, Sinking fund method of depreciation / Annuity method of depreciation, Service output method of depreciation -, Case studies (Not for Examination).

Project Management-Introduction-Phases of Project Management-Guidelines for Network Construction-Critical Path Method (CPM) - Gantt Chart/Time Chart - PERT (Project Evaluation and Review Technique).

TOTAL : 45 PERIODS

Interest table will be provided for Examination..

TEXT BOOKS:

1. Panneer Selvam. R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi, 2013.
2. Dr. K.K. Patra and Dhiraj Bhattacharjee, “Engineering Economics and Costing”, S. Chand Publishing, 2012.

REFERENCES:

1. Donald.G. Newman, Jerome.P.Lavelle, “Engineering Economics and Analysis”, Engg. Press, Texas, 2010.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, “Engineering Economy”, Macmillan, New York, 2011.
3. Dr. S. Senthil, L. Madam and N. Robindro singh, ”Engineering Economics and Cost Analysis”, Lakshmi Publications, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/110101005/
   Prof.Trupti Mishra, S.J.M. School of Management, IIT Mumbai, Managerial Economics.
2. http://nptel.ac.in/courses/109104073/
   Prof. Dr. Surajit Sinha, Department of Humanities and Social Sciences, IIT Kanpur, Macroeconomic Theory and Stabilization Policy.

21MEE45 NEW PRODUCT DEVELOPMENT L T P C
3 0 0 3

Preamble:
The objective of the course is to familiarize the participants with methods for identifying opportunities and how to convert the opportunities into commercially viable products and services. Participants will be provided with case illustrations of theoretical concepts .

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss fundamental concepts and customer specific requirements of the New Product development
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

UNIT 1 FUNDAMENTALS OF NPD 9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component
material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

UNIT 2 MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS 9

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

UNIT 3 ESSENTIALS OF NPD 9

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

UNIT 4 CRITERIONS OF NPD 9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.

UNIT 5 REPORTING & FORWARD-THINKING OF NPD 9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. Toyota Product Development System – James Morgan & Jeffrey K. Liker
2. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar
3. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark

e-RESOURCES:

1. https://onlinecourses.swayam2.ac.in/imb19_mg01/preview
2. https://onlinecourses.nptel.ac.in/noc20_mg03/preview

21MEE46 **ERGONOMICS IN DESIGN** **L T P C**
3 0 0 3

Preamble:
Knowledge of 'Ergonomics/ Human Factors Engineering' is of utmost necessity for automotive design and engineering to achieve optimal compatibility between occupants and vehicle components in terms of physical, cognitive and environmental aspects.

Course Outcomes: Upon completion of the course, students will be able to:

1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product

UNIT 1 INTRODUCTION **9**

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT 2 ERGONOMICS AND PRODUCTION **9**

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT 3 DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS **9**

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT 4 ENVIRONMENTAL FACTORS **9**

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT 5 AESTHETIC CONCEPTS **9**

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares , Francisco Rebelo
2. Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.

REFERENCES:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
3. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.

e-RESOURCES:

1. https://archive.nptel.ac.in/courses/107/103/107103084/
2. https://www.digimat.in/nptel/courses/video/107103084/L01.html

21MEE47 PRODUCTION PLANNING AND CONTROL L T P C
3 0 0 3

Preamble:
Production planning is basically a managerial function, which is mainly concerned with the following important issues, this function is performed by the managers in any manufacturing organization.

Course Outcomes: Upon completion of the course, students will be able to:
1. Understand the various components and functions of production planning and control
2. Identify the basic procedure and selection of workstudy.
3. Able to prepare production planning and control activities such as work study, product planning, production scheduling, Inventory Control.
4. Understand the various steps in process planning and production planning
5. Able to plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

UNIT 1 INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization- Break even analysis-Economics of a new design.

UNIT 2 WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT 3 PRODUCT PLANNING 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 4 PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT 5 INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. James. B. Dilworth, ”Operations management – Design, Planning and Control for manufacturing and services” Mcgraw Hill International edition 1992.
2. Martand Telsang, “Industrial Engineering and Production Management”, First edition, S. Chand and Company, 2000.

REFERENCES:

1. Chary. S.N., “Theory and Problems in Production & Operations Management”, Tata McGraw Hill, 1995.
2. Elwood S.Buffa, and Rakesh K.Sarin, “Modern Production / Operations Management”, 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., “Production Planning Control and Industrial Management”, Khanna Publishers, 1990.

e-RESOURCES:

1. https://nptel.ac.in/courses/112107143
   Industrial Engineering, IIT Roorkee. Dr. D. K. Dwivedi, Dr. Inderdeep Singh , Dr. Pradeep Kumar, Prof. P.K. Jain.
2. https://www.npcindia.gov.in/NPC/Homes1/e-learning/course?search=PRODUCTION+PLANNING+AND+CONTROL

21MET51 GAS DYNAMICS AND JET PROPULSION L T P C
3 0 0 3

Preamble:
Gas dynamics deals with the flow of fluids that undergo significant density changes such as the flow of gases through the nozzle at high speeds. The occurrence of normal shocks and constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayleigh flow) are the branches of gas dynamics used to acquire knowledge in compressible flow. It also includes fundamentals of propulsion theory along with various rocket propulsion and jet propulsion systems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Distinguish between the compressible and incompressible states of fluid.
2. Perform one dimensional isentropic analysis of the fluid flow changes in design parameters of nozzles and diffusers.
3. Interpret the effects of friction and heat transfer on compressibility of the flowing fluid.
4. Identify and explain the abnormalities in a fluid flow due to shock in a real system.
5. Explain the fundamentals of jet propulsion, propulsion cycle and rocket propulsion.

UNIT 1 COMPRESSIBLE FLOW 9

Energy and momentum equations for compressible fluid flows- various regions of flows, reference velocities- stagnation state - velocity of sound - critical states-Mach number - critical Mach number - Types of waves, Mach cone & Mach angle-effect of Mach number on compressibility.

UNIT 2 FLOW THROUGH VARIABLE AREA DUCTS: 9

Isentropic flow through variable area ducts. T-s and h-s diagrams for nozzle and diffuser flows-area ratio as a function of Mach number- mass flow rate through nozzles and diffusers - effect of friction in flow through nozzles- Use of Gas tables.

UNIT 3 FLOW THROUGH CONSTANT AREA DUCTS: 9

Flow in constant area ducts with friction (Fanno flow) – Fanno curves and Fanno flow equation, variation of flow properties-variation of Mach number with duct length. Isothermal flow with friction in constant area ducts. Flow in constant area ducts with heat transfer (Rayleigh flow) - Rayleigh line and Rayleigh flow equation, variation of flow properties, Maximum heat transfer.

UNIT 4 NORMAL SHOCK: 9

Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shocks-Prandtl Meyer equation - impossibility of shock in subsonic flows - Moving normal shocks - Flow in convergent and divergent nozzle with shock, Normal shock in Fanno and Rayleigh flows - flow with oblique shock (elementary treatment only) – Applications – Supersonic wind tunnels.

UNIT 5 PROPULSION 9

Aircraft propulsion – Types of jet engines – energy flow through jet engines, study of turbojet engine components – Diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbo jet engines –Thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbo jet engine, ram jet and pulse jet engines -Aircraft combustors.

Rocket propulsion – rocket engines thrust equation – Effective jet velocity, specific impulse – rocket engine performance-Solid and liquid propellants - comparison of different propulsion system - Applications –Space flights.

TOTAL : 45 PERIODS

DATA BOOKS:(allowed for reference during examinations also)

1. Yahya, S.M. "Gas Tables", 7th Edition, New Age International (P) Limited, New Delhi, 2016.

TEXT BOOKS:

1. Yahya, S.M. "Fundamentals of Compressible Flow", 5th Edition, New Age International (P) Limited, New Delhi, 2016.
2. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill Eduaction, 2015.

REFERENCES:

1. Ganesan. V., "Gas Turbines", 3rd Edition, McGraw Hill Education, New Delhi, 2010.
2. Somasundaram. PR.S.L., "Gas Dynamics and Jet Propulsions", 5th Edition , New Age International Publishers, 2008.
3. Babu. V., "Fundamentals of Gas Dynamics", 2nd Edition, ANE Books India, 2011.

e-RESOURCES:

http://nptel.ac.in/courses/112105182/

1. Prof. S. K. Som, Indian Institute of Technology, Kharagpur, Introduction to Fluid Machines and Compressible Flow.
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsion-systems-spring-2012/download-course-materials/
   Prof. Manuel Martinez-Sanchez, Massachusetts Institute of Technology, Introduction to Propulsion Systems.

21MEE52 **POWER PLANT ENGINEERING** **L T P C**
3 0 0 3

Preamble:
Power Plant Engineering course deals with various components, operations and applications of different types of power plants and impart the knowledge on cost concepts involved in it.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the construction and working principle of steam power plant and boilers.
2. Explain the principles and working of hydel and nuclear power plants.
3. Discuss the components and working principles of diesel and gas turbine power plants.
4. Explain the importance of renewable energy and its utilization of renewable energy sources.
5. Calculate the cost of power generation for various power plants.

UNIT 1 STEAM POWER PLANT AND BOILERS **9**

Steam power plant layout – working – Auxiliaries - Rankine cycle- improvement and limitations -Fuel and ash handling – combined cycle power generation.

Classification of Boilers – Lamont, Benson, Loeffler, Velox -Efficiency calculation.

UNIT 2 HYDEL AND NUCLEAR POWER PLANTS **9**

Hydro Electric Power Plant – Essential features, classification and operation, Prime mover – types and selection, Draft tubes – types, Methods to avoid cavitation.

Nuclear Power plants – Power reactors –Current generation power reactors – Breeder reactors - components - Safety aspects.

UNIT 3 GAS TURBINE AND DIESEL POWER PLANTS **9**

Gas turbine power plants – Thermodynamic fundamentals, combined cycle configurations, major components, Factors influencing performance of GT plants.

Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system. Starting system.

UNIT 4 RENEWABLE ENERGY **9**

Construction and working of Wind Energy Conversion System, Tidal, Solar Photovoltaic (SPV), Solar Thermal, Geo Thermal, MHD, OTEC, Biomass and Micro fuel cells -Advantages and Disadvantages.

UNIT 5 ENERGY AND ECONOMICS OF POWER PLANTS **9**

Power tariff types, load duration curve, Load sharing economics, Comparison of site selection criteria, Merits & demerits, Capital & Operating cost of different power plants.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Arora S.C and Domkundwar S, "A Course in Power Plant Engineering", 5th Edition, Dhanpat Rai & Co. Pvt Ltd., New Delhi, 2014.
2. P.K. Nag, "Power Plant Engineering", 3rd Edition, McGraw-Hill Education Pvt Ltd., New Delhi, 2009.

REFERENCES:

1. R.K.Rajput, "Power Plant Engineering", 4th Edition, Laxmi Publications, New Delhi, 2012.
2. G.D.Rai, "An Introduction to Power Plant Technology", 3rd Edition Khanna Publishers, New Delhi, 2012.
3. K.K.Ramalingam, "Power Plant Engineering", Scitech Publication (India) Pvt. Ltd., Chennai, 2011.

e-RESOURCES:

1. http://www.nptelvideos.in/2012/11/energy-resources-and-technology.html
   Prof.S.Banerjee etal., Indian Institute of Technology Kharagpur, Energy Resources and Technology
2. https://www.coursera.org/learn/future-of-energy/lecture/AykFe/the-future-of-nuclear-energy-part-1
   Prof.G.R.Tynan etal., Jacobs School of Engineering, US San Diego, What is the Future for Nuclear-Based Energy Sources?

21MEE53 **ADVANCED I.C. ENGINES** **L T P C**
3 0 0 3

Preamble:
This course makes the students to understand the basic Construction, working principles of I.C. Engines, fuel systems, design of combustion chambers, supercharging techniques & cooling system.

Course Outcomes: Upon completion of the course, students will be able to:
1. Explain the types of fuel injection system and combustion process of spark ignition engines.
2. Illustrate the combustion process and fuel spray characteristics inside the cylinder of compression ignition engines.
3. Identify the cause of the pollutant formation and emission control techniques to control pollutants in spark ignition and compression ignition engines.
4. Discuss the operation and use of air flow, pressure, temperature, speed, exhaust gas oxygen, knock and position sensor of engine management system in an automobile.
5. Compare the advantages and limitations of the recently developed IC engines over the conventional IC engines.

UNIT 1 SPARK IGNITION ENGINES **9**

Air fuel ratio requirements – Simple Carburetor - Calculation of Air-Fuel ratio - Fuel injection systems for Monopoint, Multipoint & Direct injection- Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock– Combustion chambers – Comparison of air-standard and actual cycles.

UNIT 2 COMPRESSION IGNITION ENGINES **9**

Diesel fuel injection systems - Stages of combustion – Knocking – Factors affecting knock – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – Spray structure and spray penetration – Air motion – Turbocharging.

UNIT 3 POLLUTANT FORMATION AND CONTROL **9**

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Emission (HC, CO, NO and NOX) measuring equipment - Methods of emission measurement.

Methods of controlling Emissions - Three-way Catalytic Converter, Selective Catalytic Reduction, Diesel Oxidation Catalyst and Particulate Trap - Emission norms and Driving cycles.

UNIT 4 ENGINE ELECTRONICS **9**

Basics of electronics - Engine management System- Sensors - Air flow, Pressure, Temperature, Speed, Exhaust gas Oxygen, Knock and Position, Principle of operation, Construction and characteristics.

UNIT 5 RECENT TRENDS **9**

Homogeneous Charge Compression Ignition (HCCI) engines – Lean burn engine, Stratified charge engine – Reactivity Controlled Compression Ignition (RCCI) engines, Low Temperature Combustion, Low Heat Rejection (LHR) engines, Marine Engines and Variable Compression Ratio(VCR) engine.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. Ganesan V, "Internal Combustion Engines", 4th Edition, McGraw-Hill India Pvt Ltd., 2014.
2. Domkundwar V.M. and Domkundwar A.V., "Internal Combustion Engines", 1st Edition, Dhanpat Rai & Co. Pvt. Ltd., New Delhi 2012.

REFERENCES:
1. Colin R Ferguson, Allan T Kirkpatrick "Internal Combustion Engine", 2nd Edition, John Wiley & Sons Inc., New Delhi, 2011.
2. Gupta H.N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India, 2nd Edition, 2013.
3. Dr. Sadhusingh, "Internal Combustion Engines and Gas Turbines", 1st Edition, S.K. Kataria & Sons, New Delhi 2013.

e-RESOURCES:
1. https://www.grc.nasa.gov/www/k-12/airplane/engopt.html
2. https://ocw.mit.edu/courses/...engineering/internal-combustion-engines/lecture-not

21MEE54 REFRIGERATION AND AIR CONDITIONING L T P C
3 0 0 3

Preamble:
Refrigeration and Air conditioning course provides the students with the knowledge on the principles of operations in different Refrigeration & Air conditioning systems and components and provide knowledge on design aspects of Refrigeration & Air conditioning systems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the refrigeration cycles and select environmentally benign refrigerants based on refrigerant properties.
2. Determine the COP of vapour compression refrigeration cycle with p-h and T-s diagrams.
3. Discuss the types of refrigeration systems and contemporary issues of ozone depletion and global warming potential with respect to refrigeration systems.
4. Describe the air conditioning processes using principles of Psychrometry and requirements of comfort air conditioning.
5. Estimate cooling/heating loads in an air conditioning system and impart knowledge on HVAC.

UNIT 1 AIR REFRIGERATION CYCLES AND REFRIGERANTS 9

Introduction to Refrigeration-Unit of Refrigeration and C.O.P.–Ideal Cycles- Carnot refrigeration cycle, Air refrigeration cycles, Bell Coleman and Bootstrap cycles -Refrigerants Desirable properties– Classification - Nomenclature - ODP and GWP. Selection of refrigerants, Eco friendly Refrigerants.

UNIT 2 VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapour compression cycle: p-h and T-s diagrams - Deviations from theoretical cycle – sub cooling and super heating- Effects of condenser and Evaporator pressure on COP- Multi pressure system – Low temperature refrigeration - Cascade systems – problems. Equipment: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT 3 OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and Adsorption cooling systems – construction and working principle of Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic -Vortex and Pulse tube refrigeration systems.

UNIT 4 PSYCHROMETRIC PROPERTIES, PROCESSES AND AIR CONDITIONING SYSTEMS 9

Properties of moist Air-Gibbs, Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humidity specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart, Psychrometric of air-conditioning processes, mixing of air streams. – Air distribution systems, Window, Split type, Inverter and Central air conditioning systems, Applications: Automobiles, industry, stores and public buildings.

UNIT 5 COOLING LOAD CALCULATIONS AND HVAC SYSTEMS 9

Types of load – Design of space cooling load – Heat transfer through building. Solar radiation – Infiltration – Internal heat sources (sensible and latent) – Outside air and fresh air load – Estimation of total load – Domestic, commercial and industrial systems.

Introduction to HVAC Systems – Fundamentals, Scope of HVAC, Mode of Heat Transfer and Standards.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010.
2. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.

REFERENCES:

1. Stoecker, W.F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi, 1986.
2. Jones W.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2001
3. ASHRAE Hand book, Fundamentals, 2010
4. Manohar Prasad, “Refrigeration and Air conditioning” ,New Age International (P) Ltd, NewDelhi,2010.

e-RESOURCES:

1. https://nptel.ac.in/courses/112/107/112107208/
   Prof. Ravi Kumar, IIT Roorkee, Introduction to Refrigeration
2. https://nptel.ac.in/courses/112/105/112105128/
   Prof.M.Ramgopal and Prof.R.C.Arora, IIT Khargpur, Refrigeration and Air Conditioning

21MEE55 **FLUID POWER SYSTEMS** **L T P C**
3 0 0 3

Preamble:

This course is exploring the advantages and applications of fluid power Engineering and power transmission system. To impart the knowledge on applications of fluid power system in automation of machine tools and other equipment.

Course Outcomes: Upon completion of the course, students will be able to:

1. Define various concepts of hydraulics.
2. Describe the constructional details of pumps and motors.
3. Classify and develop hydraulic circuits.
4. Identify and explain various components of pneumatic system.
5. Differentiate pneumatic and hydraulic system.

UNIT 1 FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power - Advantages of fluid power - Applications of fluid power system - Types of fluid power systems - Properties of hydraulic fluids – General types of fluids – Fluid power symbols.

Basics of Hydraulics - Applications of Pascal's Law - Laminar and Turbulent flow – Reynold's number – Bernoulli's Principle -Darcy's equation.

UNIT 2 HYDRAULIC SYSTEM & COMPONENTS 9

Pump classification – Construction & Working of Gear pump, Vane Pump, Piston pump - Pump performance – Variable displacement pumps.

Fluid Power Actuators: Linear hydraulic actuators – Types of hydraulic cylinders – Single acting, Double acting - Special cylinders like Tandem, Rodless, Telescopic, Cushioning mechanism - Construction of Double acting cylinder, Rotary actuators – Construction & Working of Gear, Vane and Piston motors.

UNIT 3 DESIGN OF HYDRAULIC CIRCUITS 9

Directional control valve – 3/2 way valve – 4/2 way valve– Shuttle valve – Check valve – Pressure control valve – Sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers: Types of accumulators – Accumulators circuits, Sizing of accumulators, Intensifier — Intensifier circuit and Application, Speed control circuits, Synchronizing circuit and Industrial application circuits – Copying circuit and Press circuit.

UNIT 4 PNEUMATIC SYSTEMS AND COMPONENTS 9

Pneumatic Components: Properties of air – Compressors – Filter, Regulator and Lubricator Unit – Air control valves, Quick exhaust valves and Pneumatic actuators.

Penumo hydraulic circuit, Sequential circuit design for simple applications using Cascade method.

UNIT 5 DESIGN OF PNEUMATIC CIRCUITS 9

Servo systems – Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Fluidics – Introduction to fluidic devices, simple circuits.

Introduction to Electro Hydraulic Pneumatic logic circuits, Ladder diagrams, Applications of PLC in fluid power control. Fluid power circuits; Failure and Troubleshooting.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education, 7th edition, 2013.
2. Majumdar.S.R., "Oil Hydraulics Systems- Principles and Maintenance", McGraw Hill Education, Reprint 2011.

REFERENCES:

1. Jagadeesha T , "Hydraulics and Pneumatics", I K International Publishing House,2015
2. Andrew Parr, "Hydraulics and Pneumatics", Elsevier Ltd, 2011.
3. Srinivasan.R, "Hydraulic and Pneumatic controls", Vijay Nicole, Second edition 2008.

e-RESOURCES:

1. http://nptel.ac.in/courses/112106175/ JagadeeshaT,Indian Institute of Technology, Chennai, Fluid Power Control.
2. https://www.youtube.com/watch?v=YxxSmz86zDg

21MEE56 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

Preamble:
Computational fluid dynamics are of great practical importance in many branches of science and engineering. Fluid dynamics addresses to introduce governing equations of viscous fluid flows and numerical modeling and its role in the field of fluid flow and heat transfer. CFD creates confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the fundamentals of governing equations of viscous fluid flow.
2. Apply the knowledge on finite difference method for fluid flow calculations.
3. Discuss the concepts of finite volume method (FVM) for diffusion.
4. Identify and explain the significance of finite volume method for convection diffusion.
5. Apply the concepts of FVM for fluid flow calculations.

UNIT 1 GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations –Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic energy equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations..

UNIT 2 FINITE DIFFERENCE METHOD 9

Derivation of finite difference equations – Simple methods – General methods for first and second order accuracy – Solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and implicit schemes – Example problems on elliptic and parabolic equations - Use of Finite Difference methods

UNIT 3 FINITE VOLUME METHOD FOR DIFFUSION 9

Finite volume formulation for steady state one, two and three dimensional diffusion problems. One dimensional unsteady heat conduction through explicit, and fully implicit schemes. Two-dimensional Transient Problems - Use of Finite Volume methods - Difference between FDM and FVM methods.

UNIT 4 FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-Properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes

UNIT 5 FLOW FIELD ANALYSIS AND MESH GENERATION 9

SIMPLE algorithm - Navier-Stokes equations- Representation of the pressure gradient term and continuity equation – Pressure correction equation- Structured grid generation - Unstructured grid generation – Mesh refinement – Adaptive mesh – Software tools- Applications of CFD.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Versteeg, H.K., and Malalasekera W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Longman, second edition, 2010.
2. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, second edition, 2011.

REFERENCES:

1. John D. Anderson, "Computational Fluid Dynamics", Mcgraw Hill Education Publisher, 2012.
2. Anil W. Date, "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2011.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", McGraw Hill Education Publishing Company Ltd., 2011.

e-RESOURCES:

1. http://nptel.ac.in/courses/112105045/
   Prof.Dr.Suman Chakrabortyetal., IIT kharagpur, Computational Fluid Dynamics
2. https://ocw.mit.edu/courses/mechanical-engineering/2-29-numerical-fluid-mechanics-spring-2015/
   Prof. Pierre Lermusiaux et.al.,Massachusetts Institute of Technology, Numerical Fluid Mechanics.

21MEE57 **CRYOGENIC ENGINEERING** **L T P C**
3 0 0 3

Preamble:
Cryogenic engineering provides the knowledge of evolution of low temperature science and the properties of materials at low temperature. Its deals with various gas liquefaction systems and to provide design aspects of cryogenic storage and transfer lines and the concept to correlate the theoretical principles with application oriented studies.

Course Outcomes: Upon completion of the course, students will be able to:
1. Identify and explain the cryogenic systems and liquefaction systems.
2. Illustrate the components of liquefaction systems.
3. Apply the knowledge on gas separation and purification systems.
4. Describe the concept of cryogenic systems and its working methods in space engine applications.
5. Explain the working of cryogenic systems and applications.

UNIT 1 INTRODUCTION TO CRYOGENIC SYSTEMS **9**
Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

UNIT 2 LIQUEFACTION SYSTEMS **9**
Liquefaction systems for Neon, Hydrogen and Helium Components of liquefaction systems – Heat Exchangers – Compressors and Expanders – Expansion valve – Losses for real machines

UNIT 3 GAS SEPARATION AND PURIFICATION SYSTEMS **9**
Gas separation and purification systems – Properties of mixtures – Principles of mixtures – Principles of gas separation – Cryogenic separation processes of air, Hydrogen, Helium –Non cryogenic separation processes of Air, Hydrogen, Helium.

UNIT 4 CRYOGENIC REFRIGERATION SYSTEMS **9**
Cryogenic refrigeration Systems – Working media – Solids, liquids and gases. Cryogenic fluid storage and transfer – Cryogenic storage systems – Insulation – Fluid transfer mechanisms – Cryostat – Cryo Coolers, Case Study on Cryogenic Machining.

UNIT 5 HANDLING OF CRYOGENS **9**
Cryogenic Dewar- Cryogenic Transfer Lines- Insulations used in Cryogenic Systems and insulating methods – Instrumentation to measure Flow.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. Thomas M.Flynn, “Cryogenic Engineering”, CRC Press, 2nd ed., 2012.
2. MamataMukhopadhyay, “Fundamentals of Cryogenic Engineering”, PHI Learning Private Limited, 1st ed., 2010.

REFERENCES:
1. Randall F. Barron., “Cryogenic Systems”, Springer,Oxford University Press, 2013.
2. S. S. Thipse,’Cryogenics: A Text Book”Alphascience,2013
3. Cryogenics process Engineering – K.D.Timmerhaus & TM Flynn, Plenum press, 2014.

e-RESOURCES:
1. http://nptel.ac.in/courses/112101004/
   Prof. M. D. Atrey, Department of Mechanical Engineering, Indian Institute of Technology, Bombay
2. https://www.cryogenicsociety.org/

21MEE61 ENTERPRISE RESOURCE PLANNING (ERP) L T P C
3 0 0 3

Preamble:
This course provides you with an understanding of what Enterprise Systems (also commonly termed as Enterprise Resource Planning Systems, ERPs) are. After learning about what these systems are, we would touch upon why these systems are useful to companies, through which you would get to see the various jobs and positions that are associated with the use and deployment of ERPs.

Course Outcomes: Upon completion of the course, students will be able to:

1. Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
2. Able to understand the development of software to integrate business activities such as inventory management and control, order tracking, customer service, finance and human resources.
3. Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.
4. Understand the architecture of various ERP packages available in the market.
5. Ability to learn the outsourcing concepts of ERP and its economics .

UNIT 1 ENTERPRISE RESOURCE PLANNING AND VALUE CHAIN MANAGEMENT 9

Principle –ERP framework –BusinessBlue Print –Business Engineeringvs Business process Re-Engineering –Tools –Languages –Value chain –Supply and Demand chain –Extended supply chain management –Dynamic Models –Process Models.

UNIT 2 TECHNOLOGY AND ARCHITECTURE 9

Client/Server architecture –Technology choices –Internet direction – Evaluation framework –CRM –CRM pricing –chain safety –Evaluation framework.

UNIT 3 ERP SYSTEM PACKAGES 9

SAP, People soft, Baan and Oracle –Comparison –Integration of different ERP applications –ERP as sales force automation –Integration of ERP and Internet –ERP Implementation strategies –Organizational and social issues

UNIT 4 ERP ARCHITECTURE 9

Overview – Architecture–AIM –applications –Oracle SCM. SAP: Overview –Architecture –applications - Before and after Y2k –critical issues –Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET.

UNIT 5 ERP PROCUREMENT ISSUES 9

Market Trends –Outsourcing ERP –Economics –Hidden Cost Issues –ROI –Analysis of cases from five Indian Companies.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Garg & Venkitakrishnan, ERPWARE , ERP Implementation Framework, , Prentice Hall, 1999
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.

REFERENCES:

1. Sadagopan.S , ERP-A Managerial Perspective, Tata McGraw Hill, 1999.
2. Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.
3. Vinod Kumar Crag and N.K.Venkitakrishnan , Enterprise Resource Planning –Concepts and Practice, Prentice Hall of India, 1998.

e-RESOURCES:

1. https://nptel.ac.in/courses/110105083
2. https://www.coursera.org/lecture/enterprise-systems/1-1b-introduction-to-enterprise-resource-planning-erp-LneSo

21MEE62 DESIGN FOR MANUFACTURE AND ASSEMBLY L T P C
3 0 0 3

Preamble:
This course is providing an overview of Design for Manufacture and Assembly (DFMA) techniques and knowledge about realization of product cost through design and process improvements.

Course Outcomes: Upon completion of the course, students will be able to:
1. Explain the importance of geometrical tolerances in manufacturing oriented design
2. Describe the design guidelines for manufacturing and assembly-oriented design
3. Discuss various form design aspects of different materials.
4. Identify and explain the machining and casting considerations for manufacturing oriented design
5 Describe the design on environment to achieve eco-friendly component design.

UNIT 1 DESIGN FOR MANUFACTURE GUIDELINES 9

Guidelines and geometric tolerance. General design principles for manufacturability-strength and mechanical factors - Geometric tolerances - Tolerance analysis- worst case method- assembly limits-design and manufacturing datum- conversion of design datum into manufacturing datum – tolerance stacks- process capability

UNIT 2 DESIGN FOR ASSEMBLY GUIDELINES 9

Principal materials- Selection of materials and process-Design- Possible solutions- Evaluation method-General.

Design guidelines for manual assembly- Assembly efficiency- Effects of part symmetry, part thickness and weight of handling time- Types of manual assembly methods- Applications of DFA methodology-Design for high speed automatic assembly and robot assembly.

UNIT 3 MACHINING CONSIDERTIONS 9

Design features to facilitate machining single point and multi point cutting tools - Doweling procedures - Reduction of machined area- Simplification by separation -Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility

UNIT 4 DESIGN FOR CASTING 9

Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes Design rules for sand castings - The die casting cycle, Determination of number of cavities and appropriate machine size in die casting - Identification of uneconomical design - Computer applications in DFMA

UNIT 5 DESIGN FOR THE ENVIRONMENT: 9

Environmental objectives - Basic DFE methods - Lifecycle assessment - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Techniques to reduce environmental impact Design to minimize material usage - Design for recyclability - Design for remanufacture - Design for energy efficiency - Design to regulations and standards

TOTAL : 45 PERIODS

TEXT BOOKS:
1. Boothroyd .G, "Product design for manufacture and assembly",Newyork,CRC press London 2010.
2. Peck,Harry., "Design for manufacture", Pitman publications, London 2013.

REFERENCES:
1. Otto,kevien and wood Kristin , "Product design", Pearson publication ,New Delhi 2004
2. Paul Rodgers, Alex Milton "Product Design" London Lawrence kins publishers,2011.
3. Bralla, "Design for manufacture Handbook",Mc graw Hill Education, Newyork,2011.

e-RESOURCES:

http://nptel.ac.in/courses/107103012/

1. Abinash Kumar Swain, Indian Institute of Technology Roorkee, Design for Manufacture and Assembly

2. http://nptel.ac.in/courses/112101005/1
Prof.Amitava De, IIT Bombay, Design for Manufacturing

21MEE63 **ROBOTICS** **L T P C**
3 0 0 3

Preamble:
This course is concerned with the expansive view of concepts, parts and dynamic properties of robots. It provides knowledge about robot end effectors and sensory devices.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the functions of the basic components of robots.
2. Explain the various types of robot drive systems and end effectors.
3. Discuss the various types of sensors and machine vision with their applications.
4. Identify the concepts of machine vision and robot kinematics.
5. Perform robotic programming for accomplishing a particular task.

UNIT 1 FUNDAMENTALS OF ROBOT **9**

Robot definition - Robot anatomy - Coordinate systems, Work envelope, Types and Classification – Specifications(Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load) - Robot parts and their Functions-Need for robots - Different applications - Multi task Robots.

UNIT 2 ROBOT DRIVE SYSTEMS AND END EFFECTORS **9**

Robot drive systems - Pneumatic drives – Hydraulic drives – Electrical drives – D.C. Servo motors, A.C. Servo motors, Stepper motor - Salient features, Applications of all these drives.

End effectors - Grippers - Mechanical grippers, Pneumatic and hydraulic grippers, Magnetic grippers, Vacuum grippers, Two fingered and three fingered grippers, Internal grippers and external grippers - selection and design considerations.

UNIT 3 ROBOT SENSORS **9**

Transducers – Requirements of a sensor – Types of sensors – Principles and Applications – Non Optical and Optical Position sensors: Piezo Electric Sensor, Linear Variable Differential Transducer (LVDT), Resolvers, Optical Encoders – Range Sensing Techniques (Triangulation Principle, Structured Lighting Approach, Laser Range Meters) – Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors) –Touch Sensors (Binary Sensors, Analog Sensors) – Slip Sensors.

UNIT 4 MACHINE VISION AND ROBOT KINEMATICS **9**

Introduction to Machine Vision – Sensing and Digitizing the data, Image Processing and Analysis – Training and Vision Systems –Introduction to Manipulator Kinematics – Forward and Inverse Kinematics – Forward and Inverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) –Problems

UNIT 5 ROBOT PROGRAMMING AND IMPLEMENTATION **9**

Programming Methods – Teach Pendant Programming, Lead through programming Methods, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End Effector commands, and Simple programs – An Approach for Implementing Robotics in Industries – Various Steps; Safety Considerations for Robot Operations.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Mikell. P. Groover, ‘Industrial Robotics : Technology, Programming and Applications’, McGraw Hill Education (India) Pvt Ltd, 2012.
2. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, ‘Robotic Engineering; an integrated approach’, Prentice-Hall India. 2011.

REFERENCES:

1. Deb, S.R. ‘Robotics Technology and Flexible Automation’,McGraw Hill Education (India) Pvt Ltd, 2010
2. Rajput R.K., ‘Robotics and Industrial Automation’, S.Chand and Company, 2016.
3. Janakiraman P.A., ’Robotics and Image Processing: an introduction’, McGraw Hill Education (India) Pvt Ltd, 2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/112101099/3 , Prof.C.Amarnath, IIT Bombay, Industrial Robotics
2. http://www.nptelvideos.in/2012/12/robotics.html
   Prof.P.Seshu, IIT Bombay, Trajectory Planning

21MEE64 **NANOTECHNOLOGY** **L T P C**
3 0 0 3

Preamble:
Nanotechnology is the science of dealing with atoms with only few nanometers in dimensions. As the size of the objects is scaled down to the nanometer regime, the material properties undergo a transformation, presenting a great potential for applications. Nanotechnology is considered more powerful than even the industrial revolution.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss with the basic sciences required to understand the fundamentals of Nanomaterial.
2. Identify the importance of the synthesis method addressed in the material properties and give practical experience of nanomaterials synthesis/properties and characterization; investigations into the various factors influence the properties of nanomaterials, optimizing the procedures, and implementations to the new designs.
3. Interpret a sound knowledge of the various concepts involved in fabrication of device architectures and able to evaluate them in advance.
4. Demonstrate the imaging techniques involved for Nano technology.
5. Elucidate on advantages of nanotechnology based applications in industries.

UNIT 1 BASICS AND SCALE OF NANOTECHNOLOGY **8**

Importance of Nanotechnology - History of Nanotechnology- Opportunity at the nano scale-length and time scale in structures-energy landscapes - Inter dynamic aspects of inter molecular forces -classification based on the dimensionality – nanoparticles - nanoclusters-nanotubes-nanowires and nanodots - Semiconductor nanocrystals - carbon nanotubes - Influence of Nano structuring on Mechanical, optical, electronic, magnetic and chemical properties

UNIT 2 NANO MATERIALS PROPERTIES AND SYNTHESIS **12**

Surface to volume ratio. Surface properties of nanoparticles. Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra. Shape impact.

Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis. Chemical Methods: Metal Nanocrystals by Reduction - Solvothermal Synthesis - Photochemical Synthesis – Sonochemical Routes- Chemical Vapor Deposition (CVD) – Metal Oxide - Chemical Vapor Deposition (MOCVD).

UNIT 3 CHARACTERIZATION OF NANOMATERIALS **9**

X-ray Diffraction Thermal Analysis Methods, Differential Thermal Analysis and Differential scanning calorimetry - Spectroscopic techniques, UV-Visible Spectroscopy – IR Spectroscopy – Microwave Spectroscopy - Raman Spectroscopy - Electron Spin Resonance Spectroscopy - NMR Spectroscopy- Particle size characterization: Zeta Potential Measurement – Particle size Analysis – X-ray Photoelectron spectroscopy

UNIT 4 IMAGING TECHNIQUES FOR NANOTECHNOLOGY **7**

Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of Optical microscopy - Scanning Electron Microscopy – Transmission Electron Microscopy – Atomic Force Microscopy – Scanning Tunneling Microscopy

UNIT 5 APPLICATIONS OF NANO TECHNOLOGY **10**

Basics of photo volataic cell-Solar energy conversion and catalysis - Molecular electronics and printed electronics –Nano electronics -Polymers with a special architecture - Liquid crystalline systems - Linear and nonlinear optical and electro-optical properties, Applications in displays and other devices - Nanomaterials for data storage - Photonics, Plasmonics - Chemical and biosensors –Nano medicine and Nano biotechnology – Nano toxicology challenges.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Pradeep. T "A textbook of Nanoscience and Nanotechnology", Tata McGraw – Hill education private ltd, 2012.
2. Rao. C. N, Muller. Cheetham A. K "Nanomaterials chemistry", Wiley-VCH, 2007.

REFERENCES:

1. Rao. C. N. R, Muller.A, Cheetham A. K "The Chemistry of Nanomaterials: Synthesis, Properties and Applications", Wiley-VCH, 2006.
2. Guozhong Cao, "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications", World Scientific Publishing Private, Ltd., 2011
3. Mark. A, Ratner and Daniel Ratner, "Nanotechnology: A Gentle Introduction to the Next Big Idea", Pearson, 2003.

e-RESOURCES:

1. https://www.btechguru.com/courses--nptel--nanotechnology-video-lecture--nt.html
2. https://nptel.ac.in/courses/118107015

21MEE65 **BIOMECHANICS** **L T P C**
3 0 0 3

Preamble:
The purpose of this course is to acquaint each student with the knowledge of mechanics of biological system and enable them to understand its applications in developing mathematical models and mechanical aspects of designing implants and biological assistive devices.

Course Outcomes: Upon completion of the course, students will be able to:
1. Define and use concepts of laws of mechanics to evaluate material properties of simple problems.
2. Draw free body diagram and apply static equilibrium to human body.
3. Design implants and Select bio compatibility materials and describe manufacturing process.
4. Apply principles of kinetics applied to the human body.
5. Explain the influence of ergonomic principles on work organisation.

UNIT 1 FUNDAMENTALS OF BIOMECHANICS **9**

Application of the laws of mechanics governing forces and motion in the context of orthodontics & orthopedic concern material properties such as- stress, strain, stiffness, springiness, and elastic limit of wire. Concepts such as forces, moments and couples, center of resistance and center of rotation, and the moment-to force ratio to control tooth & bone movements.

UNIT 2 BIOMECHANICS OF JOINTS **9**

Terminologies of Bone, ligament or muscle by name, anatomic location, function, Joints and movements. Skeletal joints, forces and stresses in human joints, free body diagrams, Analysis of rigid bodies in equilibrium, types of joint, biomechanical basic static and joint mechanics analysis of elbow, shoulder, spinal cord, hip, knee and ankle.

UNIT 3 BIOMECHANICS OF IMPLANTS **9**

Design of orthopedic implants, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

UNIT 4 APPLIED BIOMECHANICS **9**

Biofluid Mechanics: Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and Hagenpoiseuille equation, turbulent flow. Engineering approaches to standing, sitting and lying, Biomechanics of gait, application of gait and locomotion analysis.

UNIT 5 BIOMECHANICS IN ERGONOMICS **9**

Ergonomics-Injury mechanics, Mechanical exposure assessment in the design of work, Biomechanics in work seating design, Models in manual materials handling.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Y.C. Fung, “Bio-Mechanics- Mechanical Properties of Tissues”, Springer-Verlag, 1998
2. Duane Knudson, “Fundamentals of Biomechanics”, Second Edition Springer Science+Business Media, 2007

REFERENCES:

1. Marcelo Epstein, “The Elements of Continuum Biomechanics”, ISBN: 978-1-119-99923-2, 2012.
2. Shrawan Kumar, “Biomechanics in Ergonomics”, Second Edition, CRC Press 2007
3. Jay D. Humphrey, Sherry De Lange, “An Introduction to Biomechanics: Solids and Fluids, Analysis and Design”, Springer Science + Business Media, 2004.

e-RESOURCES:
1. https://nptel.ac.in/content/syllabus_pdf/112106248//
2. https://www.youtube.com/watch?v=ZVa8q5497w4, MIT

21MEE66 MICRO ELECTRO-MECHANICAL SYSTEMS L T P C
3 0 0 3

Preamble:
MEMS are composed of parts such as microsensors, microprocessors, micro actuators, units for data processing and parts that can interact with exterior pieces.

Course Outcomes: Upon completion of the course, students will be able to:
1. Identify the various characteristics of MEMS
2. Ability to understand the operation of micro devices, micro systems and their applications.
3. Understand the various sensors and its applications.
4. Ability to design the micro devices, micro systems using the MEMS fabrication process
5. Identify the polymers used in MEMS and its applications

UNIT 1 INTRODUCTION 9
Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT 2 SENSORS AND ACTUATORS-I 9
Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

UNIT 3 SENSORS AND ACTUATORS-II 9
Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

UNIT 4 MICROMACHINING 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 5 POLYMER AND OPTICAL MEMS 9
Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.

REFERENCES:

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
2. Nadim Maluf," An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
3. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2001.

e-RESOURCES:
1. https://nptel.ac.in/courses/117105082
   MEMS and Microsystems, IIT Kharagpur,Prof. Santiram Kal
2. https://onlinecourses.nptel.ac.in/noc21_ee60/preview

21MEE67 **SURFACE ENGINEERING** **L T P C**
3 0 0 3

Preamble:
This course is to impart knowledge on Surface Engineering and surface modification methods that will come in handy to solve industrial problems. This will also serve as a precursor for future research in the same field.

Course Outcomes: Upon completion of the course, students will be able to:
1. Demonstrate the various theories and practice on Surface Engineering.
2. Apply measurement techniques and carry out characterization of industrial coated surfaces.
3. Describe standard methods of testing of modified surfaces.
4. Describe various surface coating technologies and their applications in industry.
5. Able to solve the industrial practical problems that arise and also for the research.

UNIT 1 FRICTION **7**

Topography of Surfaces –Surface features–Properties and measurement–Surface interaction – Adhesive Theory of Sliding Friction–Rolling friction–Friction properties of metallic and nonmetallic materials–Friction in extreme conditions–Thermal considerations in sliding contact.

UNIT 2 WEAR **6**

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and nonmetals - International standards in friction and wear measurements

UNIT 3 CORROSION **10**

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT 4 SURFACE TREATMENTS **12**

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - 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

UNIT 5 ENGINEERING MATERIALS **10**

Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.

TOTAL : 45 PERIODS

TEXT BOOKS:
1. Gwidon Stachowiak, “Engineering Tribology”, Butterworth-Heinemann, 2016.
2. D Srinivasa Rao, “Surface engineering”, Centre for Science & Technology of Non-Aligned and Other Developing Countries (New Delhi, India), 2010.

REFERENCES:
1. Neale M.J (Editor), “The Tribology Handbook ”, Newnes. Butter worth Heinemann, U.K., 2016.
2. Bharath Bhushan, “ Introduction to Tribology”, John Wiley & Sons, 2013.
3. Basu S.K, Sengupta S.N , Ahyja B.B, “Fundamentals of Tribology”, PHI Learning(P) Ltd, New Delhi, 2011.

e-RESOURCES:
1. http://nptel.ac.in/courses/112105053/4
2. http://nptel.ac.in/courses/112102014/3

21MEO01 **INDUSTRIAL INSTRUMENTATION** **L T P C**
3 0 0 3

Preamble:

Industrial Instrumentation deals with the various types of sensors such as resistive, inductive, capacitive, photovoltaic, thermocouple etc which are used to measure the process variables such as temperature, pressure, flow, level, viscosity, density, pH, sound etc. It is indeed a great subject for instrumentation and measurement

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the principles of Pressure, Temperature, flow, level, density and viscosity measurements
2. Measure the temperature of the given system using thermometer, thermocouple and pyrometer.
3. Explain the principle and working of accelerometers and densitometers.
4. Describe the working of visual, resistance based, capacitance based, thermal based and vibrating type level measurement instruments.
5. Measure the flow of given fluid using pitot tubes, venturi meter, anemometer and ultrasonic flow meter.

UNIT 1 PRESSURE MEASUREMENT DEVICES **7**

Pressure measurement basics, Standards- Manometers – Elastic elements- Electrical methods using strain gauge-High pressure measurement-Vacuum gauges – Mcleod gauge – Thermal conductivity gauges - Ionization gauge - Selection and Application – Capacitance Pressure measurement- Piezo-electric - Calibration of Pressure gauge using dead weight tester

UNIT 2 TEMPERATURE MEASUREMENT DEVICES **10**

Definitions and standards – Primary and secondary fixed points – Calibration of thermometer, different types of filled in system thermometer – Sources of errors in filled in systems and their compensation – Bimetallic thermometers – Electrical methods of temperature measurement – Signal conditioning of industrial RTDs and their characteristics – Three lead and four lead RTDs. Thermocouples – Laws of thermocouple – Fabrication of industrial thermocouples – Signal conditioning of thermocouple output – Thermal block reference functions – Commercial circuits for cold junction compensation – Response of thermocouple – Special techniques for measuring high temperature using thermocouples – Radiation methods of temperature measurement – Radiation fundamentals – Total radiation & selective radiation pyrometers – Optical pyrometer – Two color radiation pyrometers

UNIT 3 ACCELERATION, VIBRATION, DENSITY AND VISCOSITY MEASUREMENT DEVICES **9**

Accelerometers – LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers – Mechanical type vibration instruments – Seismic instrument as an accelerometer and vibrometer – Calibration of vibration pickups – Units of density, specific gravity and viscosity used in industries – Baume scale, API scale – Pressure head type densitometer – Float type densitometer – Ultrasonic densitometer – Bridge type gas densitometer – Viscosity terms – Say bolt viscometer – Rotameter type.

UNIT 4 LEVEL MEASUREMENT INSTRUMENTS **9**

Visual techniques - Float level devices- Displacer level detectors- Rotating paddle switches diaphragm- Air purge system and differential pressure detectors - Resistance - Capacitance and RF probes - Radiation - Conductivity - Field effect - Thermal – Ultrasonic - Microwave – Radar and vibrating type level sensors – Solid level measurement - Sensor selection - Calibration and Application.

UNIT 5 FLOW MEASUREMENTS **10**

Flow measurement: Introduction - Definitions and Units - Classification of flow meters- Pitot tubes-orifice meters- Venturi tubes- flow tubes- flow nozzles - Positive displacement liquid meters- Anemometers: Hot wire/hot film anemometer- laser Doppler anemometer (LDA) - Electromagnetic flow meter - Turbine and other rotary element flow meters- ultrasonic flow meters- Measurement of mass flow rate: Radiation - Angular momentum - Impeller - Turbine - Target flow meters - Flow meter selection- Application- Calibration

TOTAL : 45 PERIODS

TEXT BOOKS:

1. E.O. Doebelin, ‘Measurement Systems – Application and Design’, Tata McGraw Hill publishing company, 2003.
2. R.K. Jain, ‘Mechanical and Industrial Measurements’, Khanna Publishers, New Delhi,1999.

REFERENCES:

1. D. Patranabis, ‘Principles of Industrial Instrumentation’, Tata McGraw Hill Publishing Company Ltd, 1996.
2. B.C. Nakra&K.K.Chaudary, ‘Instrumentation Measurement & Analysis’, Tata McGraw Hill Publishing Ltd, 2004.
3. S.K. Singh, ‘Industrial Instrumentation and Control’, Tata McGraw Hill, 2003.

e-RESOURCES:

1. http://nptel.ac.in/courses/108105064/
2. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html

21MEO02 PRODUCT DESIGN AND DEVELOPMENT L T P C

3 0 0 3

Preamble:

This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes. At the end of this course, the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools, demonstrate technical competency in practice. Function effectively in an industrial and academic environments. Engage in professional ethics and development. Enrich their society and environment through their skills.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the concept and stages involved in a generic product development process.
2. Identify the customer needs and establish the product specifications.
3. Identify concept generation activities and apply design for manufacturing concepts in estimating manufacturing costs.
4. Explain the concepts of product architecture and identify the ways to reduce the product cost.
5. Apply principles of prototyping in product development economics and effectively manage the product development projects.

UNIT 1 BASICS OF PRODUCT DESIGN 9

Introduction – Classification, Specifications of Products, Product life cycle. Introduction to product design & development, A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, the AMF organization.

UNIT 2 IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 9

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications, setting the final specifications.

UNIT 3 CONCEPT GENERATION, SELECTION & TESTING 9

Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

UNIT 4 PRODUCT ARCHITECTURE -DESIGN FOR MANUFACTURING & ASSEMBLY 9

Meaning of product architecture, establishing the architecture, platform planning, related system level design issues. Assessing the need for industrial design, industrial design process, managing the industrial design process. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

UNIT 5 PROTOTYPING , PRODUCT DEVELOPMENT ECONOMICS 9

Prototyping basics, principles of prototyping technologies, planning for prototypes, Elements of economic analysis. Sensitive analysis, project trade-offs, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, project evaluation.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGrawhill New Delhi 2011
2. Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004 , Pearson Education New Delhi.

REFERENCES:

1. David G Ullman, "The Mechanical Design Process." McGrawhill Inc Singapore 2017 N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods ." John Willey & Sons 1995
2. L D Miles "Value Engineering."
3. Hollins B & Pugh S "Successful Product Design." Butter worths London.

e-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc17_me16/preview
2. https://nptel.ac.in/courses/112107078/37

21MEO03 SUSTAINABLE MANUFACTURING L T P C
3 0 0 3

Preamble:

Sustainable manufacturing is the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Sustainable manufacturing also enhances employee, community and product safety. A growing number of companies are treating "sustainability" as an important objective in their strategy and operations to increase growth and global competitiveness. This trend has reached well beyond the small niche of those who traditionally positioned themselves as "green," and now includes many prominent businesses across many different industry sectors.

Course Outcomes: Upon completion of the course, students will be able to:

1. Identify and explain the need for sustainability practices in manufacturing of products to meet development challenges.
2. Apply the principles of design for environment in developing ecofriendly products.
3. Explain the link between manufacturing process models and sustainable manufacturing metrics for product and process improvement
4. Apply economic, environmental, and social aspects into decision making processes using multi-criteria decision making methods.
5. Explain the sustainability practices at global, regional and national levels.

UNIT 1 SUSTAINABILITY AND DEVELOPMENT CHALLENGES 9

Definition of sustainability – Environmental, Economical and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development-Millennium Development Goals- Global, Regional and Local environmental issues – Social insecurity - Resource Degradation –Climate Change.

UNIT 2 THE ART AND SCIENCE OF DESIGN FOR ENVIRONMENT 9

Management environmental Innovation – The rise of green market – Integrated product development – organizing for environmental Excellence – Practicing concurrent engineering – Understanding product life cycle – Principles of design for environment – Life cycle thinking – System perspective – Indicators and Metrics – Design strategies – Analysis method – Information technology – Learning from Nature.

UNIT 3 PRINCIPLES AND SUSTAINABILE LIVELI HOOD 9

History and emergence of the concept of sustainable development - Our Common Future – Stockholm to Rio plus 20– Rio Principles of Sustainable Development – Precautionary Principle- Polluter Pays Principle – Role of Civil Society, Business and Government -Natural Step – UN Global Compact

Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution, Preservation and Public participation.

UNIT 4 SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 9

Protecting and Promoting Human Health – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation – Biodiversity conservation and Ecosystem integrity –Ecotourism - Urbanization and Sustainable Cities – Sustainable Habitats - Green Buildings - Sustainable Transportation – Sustainable Consumption and Production – Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms.

UNIT 5 SUSTAINABILITY PRACTICES 9

Sustainability in global, regional and national context – Rio Plus 20 - Measuring Sustainability – limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Operational guidelines –- Science and Technology for sustainable development – Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning – Governance - Science and Technology- Sustainability Education.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sayer, J. and Campbell, B., The Science of Sustainable Development : Local Livelihoods and the Global Environment (Biological Conservation, Restoration &Sustainability), Cambridge University Press, London, 2004
2. "Sustainable Manufacturing: by Arun N Nambiar, CRC Press, 2014.

REFERENCES:

1. MoEF (2012), "Sustainable Development in India –stocktaking in the Run up to Rio plus 20", Ministry of environment and forests, Government of India, New Delhi.
2. G. Seliger, 2007, Sustainability in manufacturing, Springer-Verlag, Berlin.
3. Kirkby, J., O'Keefe, P. and Timberlake, Sustainable Development, Earthscan Publication, London,1993.

e-RESOURCES:

1. https://nptel.ac.in/courses/112104225/
2. https://nptel.ac.in/courses/112106249/26

21MEO04 **ENTREPRENEURSHIP DEVELOPMENT** **L T P C**
3 0 0 3

Preamble:

Entrepreneurship development is the process of improving the skills and knowledge of entrepreneurs through various training and classroom programs. By doing this, the pace at which new businesses or ventures are made gets better. On a wider level, this makes room for employment and improves the economy of a business or country.

Course Outcomes: Upon completion of the course, students will be able to:

1. Identify the role of Entrepreneurship and study the factors affecting entrepreneurial growth.
2. Apply motivational techniques for effective stress management in entrepreneurship development.
3. Identify ownership structures for better project formulation and business growth.
4. Apply knowledge on sources of finance for managing working capital.
5. Identify support institutions for the given company.

UNIT 1 ENTREPRENEURSHIP **9**

Definition - Types of entrepreneurs - Requirements to be an entrepreneur - Entrepreneur and Intrapreneur - Growth of entrepreneurship in India - Women entrepreneurship - Rural and urban entrepreneurship - Factors affecting entrepreneurial growth.

UNIT 2 ENTREPRENEURIAL MOTIVATION **9**

Major motives influencing an entrepreneur - Maslow's hierarchy of needs - Theory of Motivation, Self-rating, Business games, Thematic apperception test - Stress management, Entrepreneurship development programmes.

UNIT 3 BUSINESS **9**

Small scale enterprises – Definition, Business ownership structures – Project formulation – Steps involved in setting up a business – Identifying, selecting a good business opportunity.

Market survey and research, Techno economic feasibility assessment, Preparation of preliminary project reports – Project appraisal – Growth strategies in small industry, Sickness in small business – Concept, Magnitude, Causes and Consequences, Corrective measures.

UNIT 4 FINANCING AND ACCOUNTING **9**

Need – Sources of finance, Term loans, Capital structure, Financial institution, Management of working capital, Costing, Break even analysis, Taxation – Income Tax, Value added tax, Excise duty – Sales tax.

UNIT 5 SUPPORT TO ENTREPRENEURS **9**

Establishment of an enterprise - Systematic approach, Government support and Government industrial policy, National institute and agencies, Institutional support to entrepreneurs - Introduction about GST passed by Government of India.

TOTAL : 45 PERIODS

TEXT BOOKS:1. Khanka S.S. ,"Entrepreneurial Development", Fourth Edition, S. Chand, New Delhi, 2012.
2. Donald F Kuratko, "Entrepreneurship –Theory, Process and Practice", Tenth Edition, Cengage Learning, 2016.

REFERENCES:

1. Robert D Hisrich, Mathew J Manimala, Michael P Peters and Dean A Shepherd, "Entrepreneurship", McGraw Hill Education, New Delhi, 2016.
2. Dr.C.B. Gupta and Dr.N.P.Srinivasan, "Entrepreneurial Development", Pearson Education, New Delhi, 2012.
3. Charles Beamford and Garry D Bruton , "Entrepreneurship", McGraw Hill Education – Asia, 2015.

e-RESOURCES:

1. https://ocw.mit.edu/courses/sloan-school-of-management/15-390-new-enterprises-spring-2013/video-tutorials/lecture-1/Bill Aulet, Instructor, MIT.
2. http://nptel.ac.in/courses/122106032/24
   Dr. T. J. Kamalanabhan, IIT Madras, Management Science II.

21MEO05 **FUNDAMENTALS OF ERGONOMICS** **L T P C**
3 0 0 3

Preamble:

This course provides the basic concepts of ergonomics and various tools and techniques involved in designing comfortable and safe workplace.

Course Outcomes: Upon completion of the course, students will be able to:

1. Define ergonomics and its components.
2. Make use of statistical treatment of data in designing the components of office and shop floor.
3. Assess the common risk factors and areas for ergonomic improvement.
4. Apply ergonomic principles in framing work content for workers.
5. Plan the essential elements for an effective ergonomics programme.

UNIT 1 INTRODUCING ERGONOMICS **9**

Introducing Ergonomics: Fundamentals of Ergonomics / Human factors - Disciplines - Physical - Cognitive and Organizational - Needs of Ergonomics in workplace - Ergonomic Principles - Applications - Ergonomic Evaluation - Questionnaire survey.

UNIT 2 ANTHROPOMETRY **9**

Anthropometry: Human body - structure and function - Types of anthropometric data - Application of anthropometry in design - Anthropometric measuring techniques - Statistical treatment of data and percentile calculations.

UNIT 3 POSTURE AND MOVEMENT **9**

Posture and Movement: Biomechanical Background - Physiological Background - Sitting - Standing Change of Posture - Hand and arm postures - Movement - Lifting - Carrying - Pulling - Pushing - Repetitive motions - Rapid Upper Limb Assessment (RULA) – Rapid Entire Body Assessment (REBA) and Ovako Working Posture Assessment (OWAS) method.

UNIT 4 WORK COUNTER BEHAVIOR AND PERCEPTION **9**

Work Counter Behavior and Perception: Environmental issues - Physical work capacity - Factors affecting work capacity - Communication and cognitive issues - Information processing and perception - Interaction with machines - mental workload.

UNIT 5 WORK SYSTEM EVALUATION AND SAFETY **9**

Work system Evaluation and Safety: Contribution of ergonomics to workstation design - Analysis of workplace design - Work envelopes - Workplace evaluation tools - case studies - Occupational / Ergonomic safety and stress at various workplace - health management rules - Scope of Ergonomics in India-case studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Bridger R.S., "Introduction to Ergonomics", 3rd Edition, Taylor & Francis, New York, 2011.
2. Pamela McCauley-Bush, "Ergonomics: Foundational Principles, Applications, and Technologies", 1st Edition, Taylor & Francis, CRC Press, New York, 2011.

REFERENCES:

1. Wilson,J.R.Corlect EN, “Evaluation of Human work”, A. practical Ergonomcis methodology, Taylor and Frances, 1990.
2. Dul J. and Weerdmeester B., "Ergonomics for beginners, a quick reference guide", 3rd Edition, Taylor & Francis, New York, 2008.
3. Micormic, J. “Human factors in Engineering and Design”, McGraw Hill, 1992

e-RESOURCES:

1. https://nptel.ac.in/courses/107/103/107103004/
2. https://onlinecourses.nptel.ac.in/noc20_de12/preview

21MEO06	PRINCIPLES OF MANAGEMENT AND INDUSTRIAL PSYCHOLOGY	L T P C 3 0 0 3

Preamble:

The course provides the principles, theory and practice of management followed in organizations. In addition, it covers the skills to meet the challenges of management, human behavior in a diverse and complex environment.

Course Outcomes: Upon completion of the course, students will be able to:

1. Interpret the theory and the practice of management.
2. Demonstrate knowledge and understanding of the functions of management.
3. Define organizational behaviour and explain how managers create organizational culture.
4. Develop an intuitive understanding of the science of human behavior and the art of managing groups.
5. Develop ability for solving problems involving employee - industry relationship.

UNIT 1 PRINCIPLES OF MANAGEMENT **9**

Principles of Management: Definition and Significance of Management - Evolution of Modern Management - Scientific Management - Development of Management Thought - Approaches to the study of Management – Basic Functions of Management.

UNIT 2 FUNCTIONS OF MANAGEMENT **9**

Functions of Management: Planning - Objectives and Strategies - Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Decentralization - Organizational culture - Staffing - Selection and training - Placement - Performance appraisal - Career Strategy - Organizational Development - Leading - Managing human factor - Leadership - Communication - Controlling - Process

UNIT 3 ORGANIZATIONAL BEHAVIOUR **9**

Organizational Behaviour: Definition - Organization - Managerial Role and functions - Organizational approaches - Individual behaviour - causes - Environmental Effect - Behaviour and Performance - Perception - Organizational Implications - Personality - Contributing factors - Dimension - Need Theories - Process Theories - Job Satisfaction - Learning and Behaviour - Learning Curves - Work Design and approaches.

UNIT 4 INDUSTRIAL PSYCHOLOGY And GROUP DYNAMICS **9**

Industrial Psychology and Group Dynamics: Introduction - Concept and Meaning - Characteristics and Scope - Historical Development - Individual behaviour - Group behavior - Features of Group - Formation and Development - Types of Groups - Group Structure and Cohesiveness.

UNIT 5 INTERPERSONAL RELATIONSHIP **9**

Interpersonal Relationship: Leadership - Concept and Meaning - Principles and Theories - Managing emotions - Emotional Intelligence - Building Interpersonal Relations.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Harold Koontz & Heinz Weihrich., "Essentials of Management: An International, Innovation and Leadership Perspective", 10th Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2015.
2. Michael G Aamodt., "Industrial Psychology", 7th Edition, Cengage Learning, India, 2013.

REFERENCES:

1. Chandran J.S., "Organizational Behaviour", 3rd Edition, Vikas Publishing House Pvt. Ltd., New Delhi, 2014.
2. Govindarajan & Natarajan: Principles of Management, Prentice Hall of India Private Limited, New Delhi,2012.
3. Davis, K and Newstrom, C.W : Organizational Behavior : Human Behavior at work, McGraw -Hill,1993.

e-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_mg58/preview
2. https://nobaproject.com/modules/industrial-organizational-i-o-psychology

21MEO07 SAFETY MEASURES FOR ENGINEERS L T P C
3 0 0 3

Preamble:

The course explores the knowledge on safety aspects, procedures and guidelines to be followed in various industries, while performing various types of activities in electrical, chemical industries with appropriate personal personnel protection equipments and risk assessment procedures.

Course Outcomes: Upon completion of the course, students will be able to:

1. Perceive the safety management concepts and accident prevention methods.
2. Apply appropriate measuring and /or insulating equipment, use of fire extinguishers and safe earthing practices.
3. Identify the different source of ignition and their prevention techniques
4. Select the PPE based on the type of industry and standards.
5. Implement the techniques like risk assessment disaster management and emergency preparedness with the proper knowledge on accident prevention.

UNIT 1 SAFETY MANAGEMENT AND ACCIDENT PREVENTION 9

Introduction: Need for Safety - Safety and Productivity - Safety Management Techniques - Job Safety Analysis - Safety Sampling Technique - Incident Recall Technique - Plant Safety Inspection - Accident: Nature and Causes of Accidents - Accident Proneness - Cost of Accident - Accident Prevention Methods - Accident Reporting and Investigation - Safety Education and Training- Environmental Safety' (OHSAS, Paris Agreement etc.,)- Indian Factories Act.

UNIT 2 ELECTRICAL SAFETY EQUIPMENTS 9

Voltage Measuring Instruments: Safety Voltage Measurement - Contact and Non-Contact Type Testers Rubber Insulating Equipment: Rubber Mats - Rubber Blankets - Rubber Covers - Line Hoses and Sleeves - Inspection Techniques - Standards Insulated Tools: Hot Sticks - Cherry Picker - Standards for Tools - Safety Barriers and Signs - Safety Tags - Lock and Locking devices - Prevention from the damages of static electricity - Lighting arrester.

UNIT 3 SAFETY PRACTICES 9

Fire Extinguishers: Fire Safety Against Electrical fire - Types of Extinguishers Safety Earthing Practices: Distinction Between System Grounding and Equipment Grounding - Functional Requirement of Earthing Systems - Earth Electrodes - Types. Earth Mats - Procedure for Laying Earth Mat - Earth Resistance Measurements- First Aid-first aid for burns.

UNIT 4 PERSONNEL PROTECTION EQUIPMENT (PPE) 9

Flash and Thermal protection: Glossary of Terminologies - Flame Resistant - Arc Thermal Performance Value (ATPV) - Energy Breakthrough (EBT) - ASTM Standard for Clothing Materials - Choice of Clothing - Flame and Non-Flame Resistant Materials - Guidelines for Selection - Flash Suit Head Protection: Hard Hats – ANSI Z 89.1 Standard - Eye Protection - Requirements of Safety Glasses - Goggles - Selection - Face shield. Hearing Protection – Requirement - Ear plugs and Ear muffs - Noise Reduction Ratio - Thumb Rule. Arm and Hand Protection: Rubber Gloves - ASTM Standards - Leather Protective Glove - Level of Protection. Foot and Leg Protection and Respiratory Protection.

UNIT 5 RISK ASSESSMENT AND CONTROL TECHNIQUES 9

Risk Assessment: Basic Concepts of Risk - Safety Appraisal, Analysis and Control Techniques - Accident Investigation, Analysis and Reporting - Hazard and Risk Assessment Techniques - Reliability Engineering - Major Accident Hazard (MAH) Control - On-site and Off-site Emergency Plans.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mistry K.U., "Fundamentals of Industrial Safety and Health", 2nd Edition, Siddharth Prakashan, Ahmedabad, 2008.
2. Benjamin O.Alli, Fundamental Principles of Occupational Health and Safety ILO 2008.

REFERENCES:

1. John Cadick, Mary Capelli Schellpfeffer & Dennis Neitzell, "Electrical Safety Handbook", 4th Edition, McGraw-Hill Education, 2012.
2. Davies V.J. & Thomasin K., "Construction Safety Hand Book", 2nd Edition, Thomas Telford Ltd., London, 1996.
3. Rao S, Jain R.K. & Saluja H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", 2nd Edition, Khanna Publishers, 2012.

e-RESOURCES:

1. https://nptel.ac.in/courses/110/105/110105094/
2. https://freevideolectures.com/course/4619/nptel-principles-construction-management/24

21MEV01	FINITE ELEMENT SIMULATION USING COMMERCIAL ANALYSIS PACKAGES	L T P C 1 0 2 1

Prerequisite:

Knowledge on Design Engineering, Thermal Engineering and Fluid Mechanics.

Preamble:

This course provides analysis software packages for the students to get familiar in analysis. Computing has completely changed the world in the past decade and its power is continually increasing. Computer Aided Engineering (Analysis) is the use of Computer to support Mechanical engineers in tasks such as design, analysis, simulation, manufacture, planning, diagnosis, and repair.

Course Outcomes: Upon completion of the course, students will be able to:

1. Get familiarized with the basic concepts of solid mechanics.
2. Use ANSYS FEA for numerical simulation.
3. Demonstrate 2D and 3D ANSYS FEA.

Module 1 – STRUCTURAL TRAINING (2D PROBLEMS) 10

Workshops on 2D Meshing and Works hops on 2D Analysis. Hands-on Training in various 2D problems like planar symmetry problems, plane stress problems, plane strain problems & Axi - symmetric problems.

Modelling and Analysis of Advanced Systems (Coupled field problems and Nonlinear systems).

Module 2 – STRUCTURAL TRAINING (3D PROBLEMS) 10

Workshops on 3D Meshing and Workshops on 3D Analysis. Hands -on Training in various 3D problems, 3D Thermal problems and Coupled Field Analysis.

Module 3 – REALTIME PROBLEMS 10

Exercise on Realtime problems

TOTAL : 30 PERIODS

REFERENCES:

1. Erdogan Madenei, Ibrahim Guven, “The Finite Element Method and Applications in Engineering Using ANSYS”, Springer, 2nd Edition, 2015.

2. Mary Kathryn Thompson, John M. Thompson, “ANSYS Mechanical APDL for Finite Element Analysis, 2017 Elsevier Inc - Butterworth-Heinemann, 2017.

e-RESOURCES:

1. http://www.ansys.com
2. https://sites.ualberta.ca/~wmoussa/AnsysTutorial/

21MEV02 GEOMETRIC DIMENSIONING AND TOLERANCING L T P C
1 0 2 1

Prerequisite:
Basic Knowledge on Engineering Drawing Dimensions, Fit and Tolerance, Metrology and Workshop Practices.

Preamble:
Geometric Dimensioning and Tolerancing (GD&T) is a symbolic language on engineering drawings and computer generated 3D solid models that describes about nominal geometry and its allowable variations. This course aims to impart knowledge on various tolerances and fits for assembly conditions.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the terminology and various elements in GD&T as per standards.
2. Illustrate the various type of tolerances and fits.
3. Discuss about surface roughness and practice on drawing of engineering components.

MODULE 1 –BASIC CONCEPTS OF GD&T **10**

General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T) - Inspection of dimensional and geometrical deviations - Datums and datum systems.

MODULE 2–FORM, ORIENTATION, LOCATION AND PROFILE TOLERANCES **10**

Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances.
Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums.

MODULE 3 – SURFACE ROUGHNESS AND PRACTICES **10**

Surface Roughness parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters.
Drawing of Engineering Components like Piston, Crosshead, Connecting Rod, Plumber Block.

TOTAL : 30 PERIODS

REFERENCES:

1. Dr. R. K. Dhawan, “A Textbook of Machine Drawing”, S.Chand Publishing, New Delhi, 2016.
2. K.L Narayana, P. Kannaiah & K. Venkata Reddy, “Machine Drawing”, New Age International Publishers, New Delhi, 2006.

e-RESOURCES:

1. https://www.fictiv.com/articles/gdt-101-an-introduction-to-geometric-dimensioning-and-tolerancing
2. https://d2t1xqejof9utc.cloudfront.net/files/147765/Dimensioning%20and%20Tolerancing%20Handbook.pdf?1541238602

21MEV03 CAM USING COMMERCIAL SOFTWARE PACKAGES L T P C
1 0 2 1

Prerequisite:

Knowledge of 2D and 3D drawing and any one software packages like Pro-E, CATIA.

Preamble:

This course will introduce you to some basic manufacturing concepts and methods, take a closer look at different types of machining, and explore how CAD/CAM software interfaces with machines in addition to that a brief introduction to what Mastercam does, what it is used for, and why it is used around the world.

Course Outcomes: Upon completion of the course, students will be able to:

1. Create tool path for basic operations.
2. Create tool path for 2D machining operations.
3. Create tool path for 3D machining operations and generate CNC part programming.

MODULE 1 - LATHE **10**

2D Geometric Modeling, File conversions (Data conversions), tool paths for Turning, Facing, Grove cutting, drilling, taping and tool paths verification and CNC Part Program generation.

MODULE 2 - MILL **10**

2D and 3D Geometric Modeling, Toolpaths for 2D machining like countering, pocketing, Island pocketing, Drilling, Plan milling, Surface Modeling, 3D surfaces (Coons, Rooled, Revolved, Tabulated etc)

MODULE 2 - MACHINING **10**

Toolpaths for 3D machining, Surface machining, Verification and CNC part program generations.

TOTAL : 30 PERIODS

REFERENCES:

1. Mikell P. Groover, "Automation, Production Systems, and Computer –Integrated Manufacturing", 4th edition, Pearson , 2015.

2. Chris McMahon and Jimmie Browne, CADCAM Principles, Practice and Manufacturing Management, 2nd edition, Pearson,1998.

e-RESOURCES:

1. http://cncmanual.com/cad-cam/mastercam/
2. https://www.researchgate.net/publication/31641353_Computer_Control_of_Manufacturing_Systems_Y_Koren

21MEV04 ADVANCED MODULES FOR DESIGN ENGINEERS USING CAD PACKAGES

L T P C
1 0 2 1

Prerequisite:

Knowledge of Engineering Graphics, Computer Aided Drafting and Modeling Laboratory, Design Engineering. Computer Aided design Laboratory.

Preamble:

The course is aimed at giving exposure to and enhancing the knowledge and skills of engineers involved in CAD packages and for those who want to provide training to others in this area. It gives exposure and on hand experience in the field of CAD, Part modelling, Assembly Modelling and Detailing.

Course Outcomes: Upon completion of the course, students will be able to:

1. Design and create Part Models and Complex Assembly Models
2. Apply the concepts of sheet metal design.
3. Understand concepts of Surface Modeling.

MODULE 1 – COMPLEX PART ASSEMBLY **10**

Assembling with constraints-Assembly theory, default constraints, Coincident constraints, Distance constraints, Parallel, normal & angle constraints Exploding, Replacing components, Cross-Sections in Assemblies.

MODULE 2 – SHEET METAL DESIGN **10**

Introduction to Sheet metal Design Process, Sheet metal model fundamentals, creating primary sheet metal wall features, Creating Sheet metal Secondary wall features, Modifying Sheet metal Models, Sheet metal Bends and Setting Up the Sheet metal Environment.

MODULE 3 – SURFACE MODELING **10**

Surface Modeling overview, Advanced selection, Basic surfacing tools, Helical sweeps, Creating and Editing Solids using Quilts.

REFERENCES:

1. Sham Tickoo, “Pro/Engineer PTC Creo Parametric 3.0 for Engineers and Designers”, Dreamtech,2012.
2. Randy H. Shih, “Parametric Modeling with Creo Parametric 2.0”, SDC Publications, 2013

e-RESOURCES:

1. http://www.creo.ptc.com/
2. http://support.ptc.com/help/creo/creo_pma/usascii/tutorials_pma/tutorials_overview.html

21MEV05 PIPING DESIGN AND ENGINEERING L T P C
1 0 2 1

Prerequisite:

Knowledge on fundamentals of piping, fittings, basic standards and pipe materials.

Preamble:
This course is directed primarily to meet the needs of various industries, engineering consultants, manufacturing industries and govt. & private social sectors including oil & gas, petrochemical, refinery, power plant, pharmaceutical, textiles industries and waste water treatment plant and any type and size of organization. This course provides a systematic development of skills and knowledge of Piping Design Engineer in line with international standards.
Course Outcomes: Upon completion of the course, students will be able to:

1. Understand the basic piping requirements for design as per the international codes & standards.
2. Identify the basic components for the cost effective new installation.
3. Understand the piping equipment while improving existing piping system.

MODULE 1 – PIPING DESIGN AND ENGINEERING (FUNDAMENTALS) 10

Introduction to piping designing & engineering - Evolution of piping - Manufacturing methods - Piping materials and selection - Pipe dimensioning - Schedule numbers - Common piping abbreviations - Major organizations for standards - Commonly American code in piping ASME/ANSI - Common abbreviations etc.

MODULE 2 – BASIC PIPING COMPONENTS 10

Type of Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded fittings, pipe nipples, flanged fittings and use of fittings - Type Flange -Types, P-T ratings and facings - Gaskets, bolts and nuts - Major Valves - Types, Materials operations, applicability, codes and specifications.

MODULE 3 – PIPING EQUIPMENT 10

Horizontal vessels/accumulators, fractionation columns, pumps, heat exchangers, re-boiler, air cooled heat exchanger, cooling towers, heaters/boilers, storage tanks, fractional distillation process and vendor data drawings - Prepare layout of Different type lights

TOTAL : 30 PERIODS

REFERENCES:

1. Shrivastav A, "**Fundamentals of Pipeline Engineering", Scitus academics, 2016.**
2. Rangwala A S, "Piping dynamics", New age International Publishers, 2016.

e-RESOURCES:

1.https://nptel.ac.in/courses/103/105/103105166/

2.https://nptel.ac.in/courses/103/107/103107143/

21MEV06 **FIXTURE DESIGN** **L T P C**
1 0 2 1

Prerequisite:
Knowledge of Manufacturing Technology, Design of jigs, fixtures and press tools.

Preamble:
Fixture design is the vital part of New Product development cycle. To design and manufacturing the fixture need lot of skillsets and in depth understanding of CNC machining process and Locating / Clamping Principles.

Course Outcomes: Upon completion of the course, students will be able to:
1. Understand the concepts, purpose of Fixture Design in Industries.
2. Apply the Step by Step Procedure for Milling (VMC) Fixture Design.
3. Design and Manufacturing Drawing Preparation for VMC and HMC Fixtures.

MODULE 1 **05**
- Basic Concept of Fixture Design
- CLRO Concept of Fixture Design
- Assessment – CLRO & Fixture Design concepts
- Process Planning & Machine Selection Milling
- Assessment – Planning & Machine Selection Milling
- Component / Job Set-up
- Assessment – Component / Job Set-

MODULE 2 **05**
- Live Milling Fixture Design
- Assessment Live Milling Fixture Design
- Milling Fixture Locating Bunk Design
- Assessment Milling Fixture Locating Bunk Design
- Milling Fixture – "V"-Block Design
- Assessment- Milling Fixture
- Insights of Material Selection of Fixture Parts
- Assessment -Insights of Material Selection of Fixture Parts
- Milling Fixture – Live Example 2 Concept Design
- Assessment Live Example 2 – Milling Fixture concept Design

MODULE 3 **10**
- Drawing Layout and Types of Projection
- Assessment - Drawing Layout and Types of Projection
- Types of View and Section Views
- Assessment - Types of View and Section Views
- Limits & Fits and Surface Finish Symbols
- Assessment - Limits & Fits and Surface Finish Symbols
- Geometric Dimensioning & Tolerance
- Assessment - Geometric Dimensioning & Tolerance
- Manufacturing Drawing preparation for Fixtures
- Assessment - Manufacturing Drawing for Fixtures
- Milling Fixture Live Example 2 - Manufacturing Drawing Preparation
- Assessment - Manufacturing Drawing for Fixtures -Example 2

MODULE 4 **10**

- Milling Fixture Live Example 3 - Concept Design
- Assessment - Milling Fixture Live Example 3 - Concept Design
- Milling Fixture Live Example 3 - Manufacturing Drawing
- Assessment - Milling Fixture Live Example 3 - Manufacturing Drawing
- Concept Design of Live HMC Fixture Example 4
- Assessment - Concept Design of Live HMC Fixture Example
- HMC Fixture Live Example 4 - Manufacturing Drawing
- Assessment - HMC Fixture Live Example 4
- Live Examples of Fixture Design
- Final Project: Fixture Concept Design
- Final Project – Manufacturing Drawing

TOTAL : 30 PERIODS

REFERENCES:

1. Course Manual Provided by Kriatec Services (P) Limited and NEAT-AICTE

e-Resources:

1. https://neat.aicte-india.org/course-details/NEAT2020616_PROD_2
2. https://www.learnew.org/about-courses.php?id=149

21MEV07 MACHINE LEARNING FOR MECHANICAL ENGINEERS L T P C
1 0 2 1

Prerequisite:

Knowledge of Algebra, Statistics, Calculus and Python Programming.

Preamble:

Machine Learning focuses on developing algorithms to find patterns or make predictions from empirical data. It is a classical sub-discipline within Artificial Intelligence (AI). The discipline is increasingly used by many professions and industries to optimize processes and implement adaptive systems. This course provides a concise introduction to the fundamental concepts in machine learning and popular machine learning algorithms. This course also deals with various issues related to the applications of machine learning algorithms.

Course Outcomes: Upon completion of the course, students will be able to:

1. Define the basic terminology and and classify the techniques of machine learning.
2. Classify and explain the neural networks and evolutionary optimization techniques.
3. Apply the machine learning techniques in design of mechanical systems and condition monitoring, manufacturing and industrial Systems and for designing and manufacturing advanced machining systems and composite materials.

MODULE 1 – TERMINOLOGY (FUNDAMENTALS) 10

- Basic Terminology of Machine Learning
- Machine Learning Techniques

MODULE 2 – TOOLS 10

- Neural Networks
- Fuzzy System
- Evolutionary Optimization Techniques

MODULE 3 – APPLICATIONS 10

- Machine Learning Applications in Industrial Engineering
- Advanced Machining Systems, Composite Materials
- Condition Monitoring using Machine Learning

TOTAL : 30 PERIODS

REFERENCES:

1. Shai Shalev-Shwartz and Shai Ben-David , “Understanding Machine Learning From Theory to Algorithms”, Cambridge University Press, 2018.
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education India, 1997.

e-RESOURCES:

1. https://nptel.ac.in/courses/106/106/106106198/
2. https://nptel.ac.in/courses/106/106/106106139/

21MEM21 FOUNDATIONS OF ENTREPRENEURSHIP L T P C
3 0 0 3

Course Outcomes: Upon completion of the course, students will be able to:

1. Learn the basics of Entrepreneurship
2. Understand the business ownership patterns and environment
3. Understand the Job opportunities in Industries relating to Technopreneurship
4. Learn about applications of technopreneurship and successful technopreneurs
5. Acquaint with the recent and emerging trends in entrepreneurship

UNIT 1 INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.

UNIT 2 BUSINESS OWNERSHIP & ENVRIONMENT 9

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

UNIT 3 FUNDAMENTALS OF TECHNOPRENEURSHIP 9

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends

UNIT 4 APPLICATIONS OF TECHNOPRENEURSHIP 9

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship -– Success Stories of Technopreneurs - Case Studies

UNIT 5 EMERGING TRENDS IN ENTREPRENEURSHIP 9

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives

TOTAL: 45 PERIODS

TEXT BOOKS:

1. S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
2. Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning

REFERENCES:

1. Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall
2. Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High- Technology Ventures in Europe. Edi: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
3. Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com
4. David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
5. HarperBusiness,https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf
6. JumpStart: A Technoprenuership Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009

21MEM22 TEAM BUILDING AND LEADERSHIP MANAGEMENT FOR BUSINESS **L T P C 3 0 0 3**

Course Outcomes: Upon completion of the course, students will be able to:

1. Learn the basics of managing teams for business.
2. Understand developing effective teams for business management.
3. Understand the fundamentals of leadership for running a business.
4. Learn about the importance of leadership for business development
5. Acquaint with emerging trends in leadership effectiveness for entrepreneurs.

UNIT 1 INTRODUCTION TO MANAGING TEAMS **9**

Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

UNIT 2 MANAGING AND DEVELOPING EFFECTIVE TEAMS **9**

Team-based Organisations- Leadershp roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness

UNIT 3 INTRODUCTION TO LEADERSHIP **9**

Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment

UNIT 4 LEADERSHIP IN ORGANISATIONS **9**

Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

UNIT 5 LEADERSHIP EFFECTIVENESS **9**

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.

TOTAL: 45 PERIODS

REFERENCES:

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience, 9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).

21MEM23 CREATIVITY & INNOVATION IN ENTREPRENEURSHIP L T P C
3 0 0 3

Course Outcomes: Upon completion of the course, students will be able to:

1. Learn the basics of creativity for developing Entrepreneurship
2. Understand the importance of creative intelligence for business growth
3. Understand the advances through Innovation in Industries
4. Learn about applications of innovation in building successful ventures
5. Acquaint with developing innovative business models to run the business efficiently and effectively

UNIT 1 CREATIVITY **9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities-Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation

UNIT 2 CREATIVE INTELLIGENCE **9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training-- Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT 3 INNOVATION **9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

UNIT 4 INNOVATION AND ENTREPRENEURSHIP **9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours-Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit

UNIT 5 INNOVATIVE BUSINESS MODELS **9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity

TOTAL: 45 PERIODS

REFERENCES:

1. Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand
2. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.
3. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018
4. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014
5. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.
6. Dale Timpe, Creativity, Jaico Publishing House, 2003.
7. Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.
8. Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

21MEM24 PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS **L T P C 3 0 0 3**

Course Outcomes: Upon completion of the course, students will be able to:

1. the awareness of marketing management process
2. Understand the marketing environment
3. Acquaint about product and pricing strategies
4. Knowledge of promotion and distribution in marketing management.
5. Comprehend the contemporary marketing scenarios and offer solutions to marketing issues

UNIT 1 INTRODUCTION TO MARKETING MANAGEMENT **9**

Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT 2 MARKETING ENVIRONMENT **9**

Introduction - Environmental Scanning - Analysing the Organisation's, Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components

UNIT 3 PRODUCT AND PRICING MANAGEMENT **9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

UNIT 4 PROMOTION AND DISTRIBTUION MANAGEMENT **9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)- Logistics Management- Introduction to Retailing and Wholesaling

UNIT 5 CONTEMPORARY ISSUES IN MARKETING MANAGEMENT **9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing

TOTAL: 45 PERIODS

REFERENCES:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management, Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015
3. Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy &S.Namakumari, Macmillan Publishers India,5th edition, 2015
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

21MEM25 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS L T P C
3 0 0 3

Course Outcomes: Upon completion of the course, students will be able to:

1. To understand the Evolution of HRM and Challenges faced by HR Managers
2. To learn about the HR Planning Methods and practices
3. To acquaint about the Recruitment and Selection Techniques followed in Industries
4. To known about the methods of Training and Employee Development.
5. To comprehend the techniques of controlling human resources in organisations

UNIT 1 INTRODUCTION TO HRM 9

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM

UNIT 2 HUMAN RESOURCE PLANNING 9

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

UNIT 3 RECRUITMENT AND SELECTION 9

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

UNIT 4 TRAINING AND EMPLOYEE DEVELOPMENT 9

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices

UNIT 5 CONTROLLING HUMAN RESOURCES 9

Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends

TOTAL: 45 PERIODS

REFERENCES:

1. Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
2. Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
3. David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
4. R. Wayne Mondy, Human Resource Management, Pearson , 2015.
5. Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
6. John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
7. K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.
8. Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

21MEM26 FINANCING NEW BUSINESS VENTURES L T P C
3 0 0 3

Course Outcomes: Upon completion of the course, students will be able to:

1. Learn the basics of starting a new business venture
2. Understand the basics of venture financing.
3. Understand the sources of debt financing.
4. Understand the sources of equity financing.
5. Acquaint with the methods of fund raising for new business ventures.

UNIT 1 ESSENTIALS OF NEW BUSINES VENTURE 9

Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.

UNIT 2 INTRODUCTION TO VENTURE FINANCING 9

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Dent and Equity - Challenges and Opportunities.

UNIT 3 SOURCES OF DEBT FINANCING 9

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

UNIT 4 SOURCES OF EQUITY FINANCING 9

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

UNIT 5 METHODS OF FUND RAISING FOR NEW VENTURES 9

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

TOTAL: 45 PERIODS

REFERENCES:

1. Principles of Corporate Finance by Brealey and Myers et al.,12TH ed, McGraw Hill Education (India) Private Limited, 2018
2. Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hilld Education India Pvt Ltd ,New Delhi , 2019.
3. Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.