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 2022

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	2022

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	4	4	0	0	0	0	1	0	9	5.5	12
2	BS	11	8	0	4	0	0	0	0	23	14.1	25
3	ES	8	9	8	4	0	0	0	0	29	17.8	24
4	PC	0	0	12	15	12	13	7	0	59	36.2	48
5	PE	0	0	0	0	6	6	6	0	18	11.0	18
6	OE	0	0	0	0	3	3	3	0	9	5.5	18
7	EC	0	0	0	0	0	3	1	12	16	9.8	15
8	MC	✓	✓	✓	✓	✓	✓	✓	✓	0	0	-
9	VC	✓										-
10	OC, SC, AC	✓										-
Total Credits / Sem		23	21	20	23	21	25	18	12	163		160

HS - Humanities and Social Science
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
EC - Employability Enhancement Course (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 - 2022
Department	Mechanical Engineering	
Programme	BE- Mechanical Engineering	

SEMESTER 1

S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22MCT01	Induction Programme	TWO WEEKS							
Theory										
2	22ENT11	Communicative English (For the students admitted in AY 2022-23 only)	HS	3	0	0	3	40	60	100
2a	22ENT11	Communicative English (For the students admitted from AY 2023-24)	HS	3	0	0	3	40	60	100
3	22MAT13	Matrices and Calculus	BS	3	1	0	4	40	60	100
4	22PHT11	Engineering Physics	BS	3	0	0	3	40	60	100
5	22CYT11	Engineering Chemistry	BS	3	0	0	3	40	60	100
6	22MET11	Engineering Graphics	ES	2	0	4	4	40	60	100
7	22EET11	Basics of Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100
8	22HST11	தமிழர் மரபு / Heritage of Tamils (For the students admitted from AY 2023-24)	HS	1	0	0	1	40	60	100
Practical										
9	22PHL11	Physics and Chemistry Laboratory -I	BS	0	0	2	1	60	40	100
10	22MEL11	Workshop Practices Laboratory	ES	0	0	2	1	60	40	100
Mandatory Courses										
11	22MCT02	Universal Human Values	MC	0	0	2	0	100	0	100
			Total Credits				23			

SEMESTER 2

S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22ENT21	Professional English	HS	3	0	0	3	40	60	100
2	22MAT23	Vector Calculus and Complex Analysis	BS	3	1	0	4	40	60	100
3	22PHT21	Materials Science	BS	3	0	0	3	40	60	100
4	22CST11	Python Programming	ES	3	0	0	3	40	60	100
5	22MET21	Engineering Mechanics	ES	3	1	0	4	40	60	100
6	22HST21	தமிழரும் தொழில்நுட்பமும்/ Tamils and Technology (For the students admitted from AY 2023-24)	HS	1	0	0	1	40	60	100
7	22HST11	தமிழர் மரபு / Heritage of Tamils (For the students admitted in AY 2022-23 only)	HS	1	0	0	1	40	60	100

Practical										
8	22PHL21	Physics and Chemistry Laboratory -II	BS	0	0	2	1	60	40	100
9	22CSL11	Python Programming Laboratory	ES	0	0	2	1	60	40	100
9a	22CSL11	Python Programming Laboratory (For the students admitted from AY 2024-25)	ES	0	0	2	1	60	40	100
10	22MEL21	Computer Aided Drafting and Modeling Laboratory	ES	0	0	2	1	60	40	100
Mandatory Courses										
11	22MCT03	Environmental Science and Engineering	MC	2	0	0	0	100	0	100
							Total Credits	21		

SEMESTER 3										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22MET31	Manufacturing Processes	PC	3	0	0	3	40	60	100
2	22MET32	Fluid Mechanics and Machinery	ES	3	1	0	4	40	60	100
3	22EEC31	Electrical Drives and Control	ES	3	0	2	4	50	50	100
4	22MET33	Engineering Thermodynamics	PC	3	1	0	4	40	60	100
5	22MET34	Kinematics of Machinery	PC	2	1	0	3	40	60	100
6	22HST21	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology (For the students admitted in AY 2022-23 only)	HS	1	0	0	1	40	60	100
Practical										
7	22MEL31	Manufacturing Processes Laboratory	PC	0	0	2	1	60	40	100
8	22MEL32	Fluid Mechanics and Machinery Laboratory	PC	0	0	2	1	60	40	100
Mandatory Courses										
9	22MCL04	English for Professionals	MC	0	0	2	0	100	0	100
9a	22MCL04	English for Professionals (For the students admitted from AY 2023-24)	MC	0	0	2	0	100	0	100
							Total Credits	20		

SEMESTER 4										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22MAT44	Differential Equations and Numerical Methods	BS	3	1	0	4	40	60	100
2	22MET41	Machining Processes	PC	3	0	0	3	40	60	100
3	22MET42	Strength of Materials	PC	3	1	0	4	40	60	100
4	22MET43	Thermal Engineering	PC	3	0	0	3	40	60	100
5	22MET44	Dynamics of Machinery	PC	2	1	0	3	40	60	100
6	22MEC45	Engineering Materials and Metallurgy	ES	3	0	2	4	50	50	100

Practical										
7	22MEL41	Machining Processes Laboratory	PC	0	0	2	1	60	40	100
8	22MEL42	Thermal Engineering Laboratory	PC	0	0	2	1	60	40	100
Mandatory Courses										
9	22MCT05	Aptitude and Logical Reasoning	MC	2	0	0	0	100	0	100
							Total Credits	23		

SEMESTER 5										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22MET51	Machine Design	PC	3	1	0	4	40	60	100
2	22MET52	Automobile Engineering	PC	3	0	0	3	40	60	100
3	22MET53	Metrology and Measurements	PC	3	0	0	3	40	60	100
4		Professional Elective – 1	PE	3	0	0	3	40	60	100
5		Professional Elective – 2	PE	3	0	0	3	40	60	100
6		Open Elective – 1	OE	3	0	0	3	40	60	100
Practical										
7	22MEL51	Computer Aided Design Laboratory	PC	0	0	2	1	60	40	100
8	22MEL52	Dynamics and Metrology Laboratory	PC	0	0	2	1	60	40	100
Mandatory Courses										
9	22MCL06	Communication Skills Laboratory	MC	0	0	2	0	100	0	100
							Total Credits	21		

SEMESTER 6										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22MET61	Design of Transmission Systems	PC	2	1	0	3	40	60	100
2	22MET62	Heat and Mass Transfer	PC	3	1	0	4	40	60	100
3	22MET63	Finite Element Analysis	PC	3	1	0	4	40	60	100
4		Professional Elective – 3	PE	3	0	0	3	40	60	100
5		Professional Elective – 4	PE	3	0	0	3	40	60	100
6		Open Elective – 2	OE	3	0	0	3	40	60	100
Practical										
7	22MEL61	Design and Fabrication Project	EC	0	0	6	3	40	60	100
8	22MEL62	Simulation and Analysis Laboratory	PC	0	0	2	1	60	40	100
9	22MEL63	Heat and Mass Transfer Laboratory	PC	0	0	2	1	60	40	100
							Total Credits	25		

SEMESTER 7										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22MET71	Total Quality Management	PC	3	0	0	3	40	60	100
2	22MET72	Mechatronics	PC	3	0	0	3	40	60	100
3		Professional Elective -5	PE	3	0	0	3	40	60	100
4		Professional Elective -6	PE	3	0	0	3	40	60	100
5		Open Elective – 3	OE	3	0	0	3	40	60	100
6	22HST71	Human Values and Professional Ethics	HS	1	0	0	1	40	60	100
Practical										
7	22MEL71	Automation Laboratory	PC	0	0	2	1	60	40	100
8	22MEL72	Comprehension	EC	0	0	2	1	60	40	100
Mandatory Courses										
9	22MCT07	Indian Constitution and Traditional Knowledge	MC	2	0	0	0	100	0	100
Total Credits							18			

SEMESTER 8										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Practical										
1	22MEL81	Internship	EC	0	0	4	2	100	0	100
2	22MEL82	Project Work	EC	0	0	20	10	40	60	100
Total Credits							12			
Total Programme Credits							163			

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.

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

VERTICAL 5: THERMAL ENGINEERING										
1	22MEE51	Gas Dynamics and Jet Propulsion	PE	3	0	0	3	40	60	100
2	22MEE52	Power Plant Engineering	PE	3	0	0	3	40	60	100
3	22MEE53	Advanced I.C. Engines	PE	3	0	0	3	40	60	100
4	22MEE54	Refrigeration and Airconditioning	PE	3	0	0	3	40	60	100
5	22MEE55	Fluid Power Systems	PE	3	0	0	3	40	60	100
6	22MEE56	Computational Fluid Dynamics	PE	3	0	0	3	40	60	100
7	22MEE57	Cryogenic Engineering	PE	3	0	0	3	40	60	100
VERTICAL 6: INTER/MULTI-DISCIPLINARY COURSES										
1	22MEE61	Enterprise Resource Planning (ERP)	PE	3	0	0	3	40	60	100
2	22MEE62	Design for Manufacture and Assembly	PE	3	0	0	3	40	60	100
3	22MEE63	Robotics	PE	3	0	0	3	40	60	100
4	22MEE64	Nanotechnology	PE	3	0	0	3	40	60	100
5	22MEE65	Biomechanics	PE	3	0	0	3	40	60	100
6	22MEE66	Micro Electro-Mechanical Systems	PE	3	0	0	3	40	60	100
7	22MEE67	Surface Engineering	PE	3	0	0	3	40	60	100

OPEN ELECTIVES										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING										
1	22BMO01	Biometric systems and their applications	OE	3	0	0	3	40	60	100
2	22BMO02	Healthcare Management Systems	OE	3	0	0	3	40	60	100
3	22BMO03	Basics of Bioinformatics	OE	3	0	0	3	40	60	100
4	22BMO04	Biology for Engineers	OE	3	0	0	3	40	60	100
5	22BMO05	Regulatory requirements in Pharmaceutical Industries	OE	3	0	0	3	40	60	100
6	22BMO06	Rapid Prototyping	OE	3	0	0	3	40	60	100
7	22BMO07	Radiotheraphy basics and Applications	OE	3	0	0	3	40	60	100
8	22BMO08	Nanotechnology and Applications	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF CIVIL ENGINEERING										
1	22CEO01	Civil and Infrastructure Engineering	OE	3	0	0	3	40	60	100
2	22CEO02	Environmental Pollution and Waste Management	OE	3	0	0	3	40	60	100
3	22CEO03	Disaster Management and Mitigation	OE	3	0	0	3	40	60	100
4	22CEO04	Building Services	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
1	22CSO01	Foundation of AR/VR	OE	3	0	0	3	40	60	100
2	22CSO02	Web Designing	OE	3	0	0	3	40	60	100
3	22CSO03	Block Chain fundamentals	OE	3	0	0	3	40	60	100
4	22CSO04	Knowledge Management	OE	3	0	0	3	40	60	100
5	22CSO05	Cloud Computing Essentials	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
1	22ECO01	Consumer Electronics	OE	3	0	0	3	40	60	100
2	22ECO02	Advanced Mobile Communication	OE	3	0	0	3	40	60	100
3	22ECO03	Optoelectronics	OE	3	0	0	3	40	60	100
4	22ECO04	IOT System Design and Applications	OE	3	0	0	3	40	60	100
5	22ECO05	5G Technologies	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
1	22EEO01	Domestic and Industrial Electrical Installations	OE	3	0	0	3	40	60	100
2	22EEO02	Renewable Energy Sources	OE	3	0	0	3	40	60	100
3	22EEO03	Electric Vehicles	OE	3	0	0	3	40	60	100
4	22EEO04	Energy Auditing and Conservation	OE	3	0	0	3	40	60	100

OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING										
1	22MEO01	Industrial Instrumentation	OE	3	0	0	3	40	60	100
2	22MEO02	Product Design and Development	OE	3	0	0	3	40	60	100
3	22MEO03	Sustainable Manufacturing	OE	3	0	0	3	40	60	100
4	22MEO04	Entrepreneurship Development	OE	3	0	0	3	40	60	100
5	22MEO05	Fundamentals of Ergonomics	OE	3	0	0	3	40	60	100
6	22MEO06	Principles of Management and Industrial Psychology	OE	3	0	0	3	40	60	100
7	22MEO07	Safety Measures for Engineers	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MEDICAL ELECTRONICS										
1	22MDO01	Introduction to Medical Electronics	OE	3	0	0	3	40	60	100
2	22MDO02	Hospital Waste Management	OE	3	0	0	3	40	60	100
3	22MDO03	Hospital Information System	OE	3	0	0	3	40	60	100
4	22MDO04	IoT Applications in Healthcare	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF INFORMATION TECHNOLOGY										
1	22ITO01	Basics of Java Programming	OE	3	0	0	3	40	60	100
2	22ITO02	Ethical Hacking	OE	3	0	0	3	40	60	100
3	22ITO03	E-Commerce and Applications	OE	3	0	0	3	40	60	100
4	22ITO03	Basics of Android Application Development	OE	3	0	0	3	40	60	100
5	22ITO05	Web Essentials	OE	3	0	0	3	40	60	100
6	22ITO06	Digital Video Editing	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE										
1	22ADO01	Fundamentals of Database	OE	3	0	0	3	40	60	100
2	22ADO02	Data Science for Engineers	OE	3	0	0	3	40	60	100
3	22ADO03	Cyber Security	OE	3	0	0	3	40	60	100
4	22ADO04	Data Visualization	OE	3	0	0	3	40	60	100
5	22ADO05	Business Analytics	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF SCIENCE AND HUMANITIES										
1	22GEO01	National Cadet Corps Studies – I	OE	3	0	0	3	40	60	100
2	22GEO02	National Cadet Corps Studies – II	OE	3	0	0	3	40	60	100

MANDATORY COURSES										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22MCT01	Induction Programme	MC	TWO WEEKS						
2	22MCT02	Universal Human Values	MC	0	0	2	0	100	0	100
3	22MCT03	Environmental Science and Engineering	MC	2	0	0	0	100	0	100
4	22MCL04	English for Professionals	MC	0	0	2	0	100	0	100
5	22MCT05	Aptitude and Logical Reasoning	MC	2	0	0	0	100	0	100
6	22MCL06	Communication Skills Laboratory	MC	0	0	2	0	100	0	100
7	22MCT07	Indian Constitution and Traditional Knowledge	MC	2	0	0	0	100	0	100

VALUE ADDED COURSES										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22MEV01	Finite Element Simulation using commercial analysis packages	VC	0	0	2	1	100	0	100
2	22MEV02	Geometric Dimensioning and Tolerancing	VC	0	0	2	1	100	0	100
3	22MEV03	CAM using commercial software packages	VC	0	0	2	1	100	0	100
4	22MEV04	Advanced modules for Design Engineers using CAD Packages	VC	0	0	2	1	100	0	100
5	22MEV05	Piping Design and Engineering	VC	0	0	2	1	100	0	100
6	22MEV06	Fixture design	VC	0	0	2	1	100	0	100
7	22MEV07	Machine Learning for Mechanical Engineers	VC	0	0	2	1	100	0	100

L - Lecture Period
T - Tutorial Period
P - Practical Period

CA - Continuous Assessment
SE - Semester Examination
Tot - Total

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	

VERTICAL FOR MINOR DEGREE

VERTICAL 1: FINTECH AND BLOCK CHAIN										
1	22ITM11	Financial Management	PE	3	0	0	3	40	60	100
2	22ITM12	Fundamentals of Investment	PE	3	0	0	3	40	60	100
3	22ITM13	Banking, Financial Services and Insurance	PE	3	0	0	3	40	60	100
4	22ITM14	Introduction to Blockchain and its Applications	PE	3	0	0	3	40	60	100
5	22ITM15	Fintech Personal Finance and Payments	PE	3	0	0	3	40	60	100
6	22ITM16	Introduction to Fintech	PE	3	0	0	3	40	60	100
VERTICAL 2: ENTREPRENEURSHIP										
1	22MEM21	Foundations of Entrepreneurship	PE	3	0	0	3	40	60	100
2	22MEM22	Team Building and Leadership Management for Business	PE	3	0	0	3	40	60	100
3	22MEM23	Creativity and Innovation in Entrepreneurship	PE	3	0	0	3	40	60	100
4	22MEM24	Principles of Marketing Management for Business	PE	3	0	0	3	40	60	100
5	22MEM25	Human Resource Management for Entrepreneurs	PE	3	0	0	3	40	60	100
6	22MEM26	Financing New Business Ventures	PE	3	0	0	3	40	60	100
VERTICAL 3: PUBLIC ADMINISTRATION										
1	22ECM31	Principles of Public Administration	PE	3	0	0	3	40	60	100
2	22ECM32	Constitution of India	PE	3	0	0	3	40	60	100
3	22ECM33	Public Personnel Administration	PE	3	0	0	3	40	60	100
4	22ECM34	Administrative Theories	PE	3	0	0	3	40	60	100
5	22ECM35	Indian Administrative System	PE	3	0	0	3	40	60	100
6	22ECM36	Public Policy Administration	PE	3	0	0	3	40	60	100
VERTICAL 4: BUSINESS DATA ANALYTICS										
1	22CSM41	Statistics for Management	PE	3	0	0	3	40	60	100
2	22CSM42	Datamining for Business Intelligence	PE	3	0	0	3	40	60	100
3	22CSM43	Human Resource Analytics	PE	3	0	0	3	40	60	100
4	22CSM44	Marketing and Social Media Web Analytics	PE	3	0	0	3	40	60	100
5	22CSM45	Operation and Supply Chain Analytics	PE	3	0	0	3	40	60	100
6	22CSM46	Financial Analytics	PE	3	0	0	3	40	60	100

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY										
1	22CEM51	Sustainable infrastructure Development	PE	3	0	0	3	40	60	100
2	22CEM52	Sustainable Agriculture and Environmental Management	PE	3	0	0	3	40	60	100
3	22CEM53	Sustainable Bio Materials	PE	3	0	0	3	40	60	100
4	22CEM54	Materials for Energy Sustainability	PE	3	0	0	3	40	60	100
5	22CEM55	Green Technology	PE	3	0	0	3	40	60	100
6	22CEM56	Environmental Quality Monitoring and Analysis	PE	3	0	0	3	40	60	100
7	22CEM57	Integrated Energy Planning for Sustainable Development	PE	3	0	0	3	40	60	100
8	22CEM58	Energy Efficiency for Sustainable Development	PE	3	0	0	3	40	60	100
VERTICAL 6: ARTIFICIAL INTELLIGENCE										
1	22ADM61	Introduction to Data Science	PE	3	0	0	3	40	60	100
2	22ADM62	Principles of Artificial Intelligence	PE	3	0	0	3	40	60	100
3	22ADM63	Data Warehousing and Data Mining	PE	3	0	0	3	40	60	100
4	22ADM64	Machine Learning Techniques	PE	3	0	0	3	40	60	100
5	22ADM65	Expert Systems	PE	3	0	0	3	40	60	100
6	22ADM66	Cognitive Science	PE	3	0	0	3	40	60	100
7	22ADM67	Gamification	PE	3	0	0	3	40	60	100

22MCT01	INDUCTION PROGRAMME (Common to all Branches)	L	T	P	C
		-	-	-	0

Preamble:

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. " Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program:

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii)Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty

mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:

- Guide to Induction program from AICTE

22ENT11 **COMMUNICATIVE ENGLISH** **L T P C**

(Common to all B.E /B. Tech Programmes) **3 0 0 3**

(For the students admitted in AY 2022-23 only)

Preamble :

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English aims at developing Communication Skills in English which is essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with LSRW skills.

UNIT 1 INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 9

Listening: Listening for General Information - Specific Details – Conversations - Telephone Conversation - Listening to Voicemail and Messages - Listening and Filling a form **Speaking**: Self Introduction - Introducing a Friend - Politeness Strategies - Telephone Conversation - Leave a Message with Another Person - Asking for Information to Fill Details in a form **Reading:** Reading Brochures - Telephone Messages - Social Media Messages relevant to Technical Contexts **Writing:** Writing Reviews - Book/Movie – Writing about Oneself **Grammar & Vocabulary:** Tenses - Types of Questions - Parts of Speech - Contextual Meaning of Words - Abbreviations and Acronyms.

UNIT 2 EXPRESSING CASUAL CONVERSATIONS 9

Listening: Information about Hotels and Accommodation - Recipes and Food Items - Listening to Conversations Asking for and Giving Directions – Making an Enquiry **Speaking:** Life Style Changes and Making Comparisons - Talking about Food - Making Conversation using Asking for Directions - Making an Enquiry - Role Plays - Dialogues **Reading**: Habit Formation and Changing Habits - International Cuisine - Reading a Print Interview and Answering Comprehension Questions **Writing**: E-Mail to Friend – E-Mails about Food and Recipes, Inviting Dignitaries, Accepting and Declining Invitations **Grammar & Vocabulary**: Evaluations and Comparisons with Adjectives – Prepositions - Modifiers.

UNIT 3 CLARIFICATIONS AND RECOMMENDATIONS 9

Listening: Listening to Short Talks and Fill a table – Gap Filling Exercises - Note Taking **Speaking:** Group Discussion - Agreeing and Disagreeing - Tips and Strategies for GD **Reading:** Reading Problems and Solutions – Articles - Essays drawn from various sources **Writing:** Making Recommendations - Giving Instructions - Note Making - Itinerary- Process Description **Grammar & Vocabulary**: Word Formation - Compound Nouns - Phrasal Verbs.

UNIT 4 PUBLIC SPEAKING AND BUSINESS COMMUNICATION 9

Listening: Listening to Speeches by Famous People and Identifying the Central Message of the Speech - Answering Multiple Choice Questions **Speaking**: Welcome Address - Vote of Thanks - Special Address on Specific Topic **Reading**: Life and Achievements of a Famous Personality - Reading Motivational Essays on Famous Engineers and Technologists **Writing:** Checklists - Business Communication - Quotations, Placing Orders, Complaints **Grammar & Vocabulary**: Modal Verbs and Probability - Collocations – Fixed Expressions - Semi-Fixed Expressions.

UNIT 5 WRITING DEFINITIONS AND PRODUCT DESCRIPTIONS 9

Listening: Listening to Product Description - Labeling and Gap Filling Exercises - Seeking help with Office Equipment - Job Details **Speaking:** Describe a Product - Compare and Contrast with other Products - Buying a Product - Selling a Product - Cancelling and Fixing Appointments - Hotel Accommodation - Training Facilities - Conference Facilities **Reading:** Reading Graphical Material for Comparison (advertisements) - Clarifying an Error in the Bill **Writing:** Writing Definitions – Single Line Definition and Extended Definition - Compare and Contrast Paragraphs - Designing a Website **Grammar & Vocabulary**: Use of Discourse Markers – One Word Substitution.

Total: 45

TEXT BOOKS:

1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level 1, Student's Book) Cambridge University Press, New Delhi: 2017.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook, Oxford University Press, 2020.

REFERENCES:

1. M Ashraf Rizvi, "Effective Technical Communication", McGraw-Hill, 2nd Edition, New Delhi, 2018.
2. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

e -Resources :

1. https://learnenglish.britishcouncil.org/intermediate-vocabulary
2. http://www.usingenglish.com
3. https://learnenglish.britishcouncil.org/intermediate-grammar
4. https://learnenglish.britishcouncil.org/speaking

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

CO1 Converse and read fluently using basic grammar components.
CO2 Communicate through writing without any grammatical errors.
CO3 Write clear, coherent and organized passages adhering to instructions.
CO4 Speak effectively in real-time and business situations.
CO5 Enhance vocabulary through listening and reading.

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					1	3			2	3		1		
CO 2					1	3			2	3		1		
CO 3					1	3			2	3		1		
CO 4					1	3			2	3		1		
CO 5					1	1			2	3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ENT11 **COMMUNICATIVE ENGLISH** **L T P C**

(Common to all B.E./B. Tech Programmes) **3 0 0 3**

(For the students admitted from AY 2023-24)

Preamble :

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English aims at developing Communication Skills in English which is essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with LSRW skills.

UNIT 1 INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 9

Listening: Listening for General Information - Specific Details – Conversations - Telephone Conversation - Listening to Voicemail and Messages – Gap Filling **Speaking**: Self Introduction – Expressing Opinions - Introducing a Friend - Telephone Conversation - Leave a Message - **Reading:** Reading Brochures and Pamphlets **Writing:** Writing Reviews - Book/Movie – Writing about Oneself **Grammar & Vocabulary:** Parts of Speech - Tenses - Contextual Meaning of Words - Abbreviations and Acronyms.

UNIT 2 EXPRESSING CASUAL CONVERSATIONS 9

Listening: Information about Hotels and Accommodation - Recipes and Food Items - Listening to Conversations Asking for and Giving Directions – Making an Enquiry **Speaking:** Talking about Daily Routine - Talking about Food - Making Conversation using Asking for and Giving Directions - Making an Enquiry - Role Plays - Dialogues **Reading**: International Recipes - Reading a Print Interview and Answering Comprehension Questions **Writing**: E- Mail to a Friend – E-Mails about Food and Recipes, Inviting Dignitaries, Accepting and Declining Invitations **Grammar & Vocabulary**: Evaluations and Comparisons with Adjectives - Word Formation.

UNIT 3 CLARIFICATIONS AND RECOMMENDATIONS 9

Listening: Listening to Short Talks and Fill a table – Gap Filling Exercises - Note Taking **Speaking:** Group Discussion - Agreeing and Disagreeing - Tips and Strategies for GD **Reading:** Articles - Essays drawn from various sources - Note Making **Writing:** Writing Recommendations - Giving Instructions – Itinerary - Process Description **Grammar & Vocabulary**: Prepositions - Modifiers - Phrasal Verbs.

UNIT 4 PUBLIC SPEAKING AND BUSINESS COMMUNICATION 9

Listening: Listening to Speeches by Famous People and Identifying the Central Message of the Speech - Answering Multiple Choice Questions **Speaking**: Welcome Address - Vote of Thanks - Special Address on Specific Topic **Reading**: Life and Achievements of Famous People **Writing:** Checklists – Personal Letters **Grammar & Vocabulary**: Modal Verbs and Probability - Collocations – Fixed Expressions - Semi-Fixed Expressions.

UNIT 5 WRITING DEFINITIONS AND PRODUCT DESCRIPTIONS 9

Listening: Listening to Product Description - Labeling and Gap Filling Exercises - Seeking help with Office Equipment - Job Details **Speaking:** Describe a Product - Compare and Contrast with other Products - Buying a Product - Selling a Product - Cancelling and Fixing Appointments - Hotel Accommodation **Reading:** Reading Graphical Material for Comparison - Tables - Pie Charts **Writing:** Writing Definitions – Single Line Definition and Extended Definition - Compare and Contrast Paragraphs - Clarifying an Error in the Bill **Grammar & Vocabulary**: Types of Questions - Use of Discourse Markers – One Word Substitution.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level 1, Student's Book) Cambridge University Press, New Delhi: 2017.

REFERENCES:

1. M Ashraf Rizvi, "Effective Technical Communication", McGraw-Hill, 2nd Edition, New Delhi, 2018.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook, Oxford University Press, 2020.
3. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

e. RESOURCES :

1. https://learnenglish.britishcouncil.org
2. https://www.usingenglish.com

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

CO1 Converse and read fluently using basic grammar components.
CO2 Communicate through writing without any grammatical errors.
CO3 Write clear, coherent and organized passages adhering to instructions.
CO4 Speak effectively in real-time and business situations.
CO5 Enhance vocabulary through listening and reading.

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					1	3			2	3		1		
CO 2					1	3			2	3		1		
CO 3					1	3			2	3		1		
CO 4					1	3			2	3		1		
CO 5		1			1	1			2	3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MAT13	MATRICES AND CALCULUS (Common to B.E - CE and ME Programmes)	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.

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 DIFFERENTIAL CALCULUS **9+3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

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

Curvature – Radius, Centre and Circle of curvature in Cartesian form - Evolute – Envelope of family of curves with one and two parameters**.**

UNIT 4 MULTIVARIABLE CALCULUS **9+3**

Partial derivatives – 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 INTEGRAL CALCULUS **9+3**

Definite and Indefinite integrals - Substitution rule - Integration by parts, Integration of rational functions by partial fraction, Area as a double integral in Cartesian and Polar forms – Volume as triple integral in Cartesian coordinates

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26thReprint, New Delhi, 2016
2. Anton.H,Bivens.IandDavis.S,"Calculus",Wiley,10th Edition,2016

e-Resources:

1. https://nptel.ac.in/courses/111106146. A course on Basic Calculus –I by Prof.Arindama Singh, Departmentb of Mathematics , IIT Madras.
2. https://nptel.ac.in/courses/111106051.A Course on Linear algebra ,by Prof.K.C.Sivakumar ,IIT Madras.

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

CO1	Determine eigenvalues and eigenvectors of real symmetric matrices and reduce the quadratic form to canonical form by orthogonal transformation.
CO2	Apply differential calculus tools in solving various application problems.
CO3	Determine evolute and envelope of curves using curvature.
CO4	Calculate partial derivatives of a function and identify the extrema on an interval.
CO5	Apply different integration methods and multiple integral ideas in solving areas, volumes and other practical problems.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2								1		
CO 2	3	3	2	2								1		
CO 3	3	3	2	2								1		
CO 4	3	3	2	2								1		
CO 5	3	3	2	2								1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22PHT11	ENGINEERING PHYSICS	L	T	P	C
	(Common to all B.E /B. Tech Programmes)	3	0	0	3

Pre-requisites : HSC Physics

Preamble

This course aims to impart the essential concepts of laser, fibre optics, ultrasonics, quantum physics and crystal structure and crystal defects. It also describes the physical phenomena related to the above mentioned concepts and their applications in engineering and provides motivation towards innovations.

UNIT I LASER **9**

Introduction –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.

UNIT II FIBRE OPTICS **9**

Principle and propagation of light in optical fibres – numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – double crucible technique of fibre drawing - splicing, losses in optical fibre, dispersion - fibre optical communication system (Block diagram) - light sources - detectors - fibre optic sensors – temperature & displacement - endoscope.

UNIT III ULTRASONICS **9**

Introduction – Production – 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 displays, medical applications - sonograms.

UNIT IV QUANTUM PHYSICS **9**

Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory – Compton effect - theory and experimental verification – matter waves – Schrödinger's wave equation – time independent and time dependent equations – physical significance of wave function – particle in a one dimensional box.

UNIT-V CRYSTAL PHYSICS **9**

Lattice – unit cell – Bravais lattice – lattice planes – Miller indices – d spacing in cubic lattice – calculation of number of atoms per unit cell – atomic radius – coordination number – packing factor for SC, BCC, FCC and HCP structures – NaCl, ZnS, diamond and graphite structures – polymorphism and allotropy - crystal defects – point, line and surface defects.

Total: 45

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. Palanisamy P.K., "Engineering Physics", 2nd Edition, Scitech Publications, 2011
3. Chitra Shadrach and Sivakumar Vadivelu, "Engineering Physics", 1st Edition, Pearson Education, 2007.

e-RESOURSES

1. http://oupinheonline.com/book/bhattacharya-tandon-engineering-physics/9780199452811.
2. https://www.khanacademy.org/science/physics/quantum-physics.

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

CO1 Compare Nd-YAG, CO_2 and Semiconductor lasers for welding, heat treatment, cutting, medical applications and holography using Stimulated Emission.
CO2 Demonstrate the knowledge of wave optics using light waves for communication system.
CO3 Describe the production and applications of ultrasonics.
CO4 Examine the dual nature of light waves using quantum theory for Black body radiation and Schrodinger's wave equations in particle in a one and three dimensional box.
CO5 Explain the description of a crystal structure in terms of atom positions, unit cells, and crystal symmetry; and to relate the crystal symmetry to the symmetry observed in a diffraction experiment.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1	1	1	1			1	1	1		
CO 2	3	2	1	1	1	1	1			1	1	1		
CO 3	3	2	1	1	1	1	1			1	1	1		
CO 4	3	2	1	1	1	1	1			1	1	1		
CO 5	3	2	1	1	1	1	1			1	1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22CYT11	ENGINEERING CHEMISTRY (Common to all B.E/B.Tech Programmes)	L 3	T 0	P 0	C 3

Preamble

The study of water technology enables engineers to acquire skills to choose the appropriate method of water treatment for industrial and domestic purposes. Electrochemistry and corrosion explain the fundamentals, identification and corrosion prevention for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage devices. Nanochemistry empowers engineers to acquire knowledge about nanomaterials and their applications in various fields. Polymeric materials aim to equip the engineering students to realize the importance of chemistry in composites and conducting polymers.

UNIT 1 WATER TECHNOLOGY *9*

Hardness – types and its units – Boiler troubles – scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming – Internal conditioning – carbonate and calgon conditioning - External conditioning – demineralization process – Desalination – electrodialysis, reverse osmosis - Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods – Ozonisation).

UNIT 2 ELECTROCHEMISTRY AND CORROSION *9*

Electrochemistry – Emf Series and its applications. Metal Finishing – Manufacture of Printed Circuit Board.

Corrosion – mechanism – Galvanic, atmospheric (O_2) and Pitting corrosion. Protective coating – electroplating of nickel and electroless copper plating on printed circuit board.

UNIT 3 ENERGY STORAGE DEVICES *9*

Batteries – types – Construction and working of Primary battery – Zinc-Air/carbon, Secondary batteries – Lead-acid battery and Lithium-ion battery, Fuel cells – H_2-O_2 fuel cell and Microbial fuel cell.

UNIT 4 NANOCHEMISTRY *9*

Nanomaterials –Types – Synthesis – sol-gel and laser ablation – Characterization – Scanning Electron Microscope and Transmission Electron Microscope – Principle and instrumentation (block diagram) – Properties – optical, electrical, mechanical and magnetic and Applications of nanomaterials – medicine, agriculture, electronics and catalysis.

UNIT 5 POLYMERS *9*

Polymers – thermoplastics and thermosetting plastics – polymerization – types (definition only) – Compounding of plastics – fabrication – compression and injection – Composites – polymer matrix composites (Fibre reinforced composites) and metal matrix composites – Conduction polymers – General mechanism of conduction in polymers.

Total : 45

TEXT BOOKS:

1. Engineering chemistry, 17th Edition. P. C. Jain & Monica Jain, Dhanpat Rai Publishing Company, 2021.
2. Applied chemistry, 2nd Edition. P. N. Palanisamy, P. Manikandan, A. Geetha, K. Manjula Rani, McGraw Hill Education (India) Private Limited, 2019.

REFERENCES:

1. Wiley Engineering Chemistry, 2nd Edition, Wiley,Wiley India Pvt. Ltd, New Delhi, 2014.
2. Engineering chemistry, 2nd Edition. O. G. Palanna, McGraw Hill Education (India) Private Limited, New Delhi, 2017.
3. A Textbook of NanoScience, 2nd Edition, Dr. Rakesh Kumar, Dr. Kamala Pati Tiwary, S. K. Kataria & Sons, New Delhi, 2013.

e-Resources:

1. http://nptel.ac.in/courses/113105028/ , "Science and Technology of Polymers"- Prof. Basudam Adhikari, Materials Science Centre, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/118/102/118102003/ , "Nano structured materials-Synthesis, Properties, Self-Assembly and Applications" - Prof. Ashok K Ganguli, Department of Chemistry, IIT Delhi

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

CO1	Evaluate the process to purify hard water using internal and external treatment.
CO2	Apply the principle of electrochemistry in PCB etching and surface coating to prevent corrosion.
CO3	Compare and contrast the performance of primary, secondary and flow battery.
CO4	Analyze the characteristics of nanomaterials synthesized by top down and bottom-up process with the aid of SEM and TEM.
CO5	Categorize the types of polymeric materials and fabrication of plastic by injection and compression molding for engineering applications.

COs\POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	2	1	1	1	2		1	1	1	1		
CO2	3	2	2	1	1	1	2		1	1	1	1		
CO3	3	2	2	1	1	1	2		1	1	1	1		
CO4	3	2	2	1	1	1	2		1	1	1	1		
CO5	3	2	2	1	1	1	2		1	1	1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET11	ENGINEERING GRAPHICS (Common to all B.E/B.Tech Programmes)	L	T	P	C
		2	0	4	4

Pre-requisites: Basic Geometry

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.

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 – Diagonal scales and vernier scales- Lines, lettering and dimensioning - Basic geometrical constructions (circular and polygonal surfaces). (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 PLANE SURFACES 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 and trapezoidal method.

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

UNIT 3 PROJECTION OF SOLIDS 12

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 FREE HAND SKETCHING 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.

Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views. Perspective projection of simple solids (Qualitative only).

Introduction to CAD software (Not for Examinations)

Lecture : 45, Practical : 15, Total : 60

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

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

CO1 Draw the various conic sections and Engineering curves
CO2 Sketch projections of lines and planes with vertical and inclined positions
CO3 Draw the projections of solids kept in various positions.
CO4 Sketch sectioned views of solids and development of surfaces.
CO5 Draw the isometric and orthographic views from given pictorial views.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1							2		1		
CO 2	3	2	1							2		1		
CO 3	3	2	1							2		1		
CO 4	3	2	1							3		2		
CO 5	3	2	1							3		2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING **L T P C**
(Common to B.E – CE and ME Programmes) **3 0 0 3**

Pre-requisites : Nil

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.

UNIT 1 DC CIRCUITS AND AC CIRCUITS **9**

DC Circuits: Basic Definitions - Resistance: Resistors in Series and Parallel - Ohm's Law - Method of solving a circuit by Kirchoff's laws. AC Circuits: Basic Definitions - Alternating Voltage and Current, R.M.S and Average Value, Power Factor, Form Factor and Peak Factor - Analysis of AC Circuit: R, L, C, Series RL, RC & RLCCircuits.

UNIT 2 POWER SYSTEMS **9**

Structure of Power System - Generation: Introduction to Conventional and Non Conventional Energy Sources - Transmission: Overhead and Underground Systems - Distribution: Single phase and three phase system - Basic principles of Earthing.

UNIT 3 ELECTRICAL MACHINES **9**

Laws of Electromagnetic Induction – Fleming's Right and Left hand rules – Lenz's law. DC Generator: Construction and working principle - DC Motor: Construction and working principle - Single Phase Induction Motor: Split Phase and Capacitor Start Induction Motor.

UNIT 4 ELECTRONICS DEVICES **9**

PN junction Diode and its Characteristics - Zener Diode and its Characteristics - Half and Full wave Rectifiers - Bipolar Junction Transistor - CE configuration and its characteristics.

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 - Half adder and Full adder circuits.

Lecture : 45, Total : 45

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. SedhaR.S.,"Applied Electronics",S.Chand& Company Ltd,2006.
3. Thomas L.Floyd.,"DigitalFundamentals",PearsonEducation,PrenticeHall,Tenth Edition,2010.

e-Resources:

1. NPTEL, http://nptel.ac.in/courses/117106101/ , "Basic Electrical Circuits", Prof. NagendraKrishnapura, IIT,Madras.
2. NPTEL, http://nptel.ac.in/downloads/108105053/ , "Basic Electrical Technology", Prof. Dr. L. Umanand, IIS,Bangalore.

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

CO1 Analyze the various DC and AC circuits and find the circuit parameters.
CO2 Describe the principles of power system engineering.
CO3 Illustrate the construction and working principle of electrical machines.
CO4 Explain the basics of semiconductor devices and its applications.
CO5 Describe the basics of Number systems and Logic gates.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3	2				1					1		
CO 2	2	3	2				1					1		
CO 3	2	3	2				1					1		
CO 4	2	3	2				1					1		
CO 5	2	3	2				1					1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22HST11	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT 1 LANGUAGE AND LITERATURE **3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT 2 HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE **3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT 3 FOLK AND MARTIAL ARTS **3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT 4 THINAI CONCEPT OF TAMILS **3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT 5 CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE **3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total : 15

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொழியியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22PHL11	PHYSICS AND CHEMISTRY LABORATORY - I	L	T	P	C
	(Common to all B.E/B.Tech Programmes)	0	0	2	1

Preamble

This course aims to impart knowledge in the determination of the physical parameters such as wavelength of laser and mercury spectrum, Numerical aperture and acceptance angle of an optical fiber, velocity of ultrasonic waves and thermal conductivity of bad conductor and additionally necessitate the practical skills in determination of rate of corrosion in mild steel, water quality parameters and amount of iron in the given sample.

PHYSICS LABORATORY I

LIST OF EXPERIMENTS

1. Determination of Optical property of Laser and Particle size of Lycopodium powder.
2. Determination of Numerical aperture and acceptance angle of an optical fiber.
3. Determination of velocity of ultrasonic waves- Ultrasonic Interferometer.
4. Determination of wavelength of mercury spectrum- Spectrometer grating.
5. Determination of Thermal conductivity of Bad conductor.

CHEMISTRY LABORATORY I

LIST OF EXPERIMENTS

1. Determination of alkalinity in water sample
2. Determination of Calcium and Magnesium hardness in water by EDTA method.
3. Determination of rate of corrosion in Mild steel by weight loss method.
4. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline / thiocyanate method).
5. Determination of iron content of the given solution using a potentiometer

Total : 45

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

CO1 Experiment and determine the optical property of light sources and acceptance angle of optical fiber using Laser and Spectrometer.

CO2 Experiment and determine the velocity of ultrasonic waves and thermal conductivity of a given bad conductor using ultrasonic interferometer and Lee's disc.

CO3 Experiment and estimate type and amount of alkalinity, Calcium and Magnesium hardness in water sample using titrimetry.

CO4 Experiment and determine the rate of corrosion in mild steel by weight loss method.

CO5 Experiment and determine the amount of iron content present in the given sample using potentiometer and spectrophotometer.

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1		3		1	1		1	1	1	1		
CO2	2	1		3		1	1		1	1	1	1		
CO3	2	1		3		1	1		1	1	1	1		
CO4	2	1		3		1	1		1	1	1	1		
CO5	2	1		3		1	1		1	1	1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL11	WORKSHOP PRACTICES LABORATORY	L	T	P	C
		0	0	2	1

Pre-requisites: Nil

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

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:

a. Tee Lap joint
b. 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. Staircase 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

REFERENCES:

1. Manual prepared by the faculty of Mechanical Engineering Department, VCET.

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

CO1 Fabricate various joints by carpentry and to prepare plumbing line assemblies.
CO2 Fabricate various joints through arc welding and gas welding processes.
CO3 Perform metal forming and basic machining operations.
CO4 Construct various types of domestic wiring and measure the various electrical parameters.
CO5 Develop and test circuits with active elements and verify truth table of logic gates.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1		3			2	2		1		
CO 2	3	2	1	1		3			2	2		1		
CO 3	3	2	1	1		3			2	2		1		
CO 4	3	2	1	1		3			2	2		1		
CO 5	3	2	1	1		3			2	2		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCT02

UNIVERSAL HUMAN VALUES **L T P C**

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

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

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".

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.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1						3								
CO 2						3		2						
CO 3						3		2						
CO 4						3		2	2					
CO 5						3			2					

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ENT21 **PROFESSIONAL ENGLISH** **L T P C**

(Common to all B.E./B. Tech Programmes) **3 0 0 3**

Preamble:

The course Professional English aims at developing LSRW skills which are essential for the learners to communicative effectively and appropriately in professional contexts through acquisition of grammar and vocabulary.

UNIT 1 ANALYTICAL READING **9**

Listening: Listening to Anecdotes - Stories - Event Narration – Documentaries and Interviews with Celebrities - Advertisements - Listening and Gap Filling Exercises **Speaking**: Conversation Skills – Initiating - Turn Taking - Closing – Explaining how something works - Persuasive Speech Techniques **Reading:** Reading Advertisements - User Manuals - Analytical Reading - Deductive and Inductive Reasoning **Writing**: Professional E-mails – E-mail Etiquette – Compare and Contrast Essays **Grammar & Vocabulary**: Prepositional Phrases –Same Word used as Different Parts of Speech.

UNIT 2 SUMMARISING **9**

Listening: Listening to Lectures - Talks and Completing Gap Filling Exercises on Science and Technology – Listening Technical Information from Podcasts **Speaking**: Summarizing - Oral Reporting – Narrating Personal Experiences – Events – Interviewing a Celebrity **Reading:** Reading Scientific and Technical Articles - Texts **Writing:** Lab Reports - Summary Writing. **Grammar & Vocabulary**: Impersonal Passive Voice - Purpose Expressions.

UNIT 3 DESCRIBING VISUAL MATERIALS **9**

Listening: Listening to the Panel Discussion **Speaking**: Speaking at Formal Situations –Mini Presentation and Making Recommendations **Reading:** Reading Journal Articles - Speed Reading - Interpretation of Graphics – Flow Chart - Bar Chart **Writing**: Data Commentaries - Describing Visual Materials – Mechanics of Writing - Writing Complaints to Editorial Columns **Grammar & Vocabulary:** Subject-Verb Agreement – Pronouns - Relative Pronouns - Numerical Adjectives.

UNIT 4 WRITING E-MAILS AND JOB APPLICATION LETTERS **9**

Listening: Listening to Model Interviews **Speaking**: Speaking at Interviews – Role Play Practice **Reading:** Reading Job Advertisements and Company Profile - Statement of Purpose (SOP) **Writing:** Filling up the Job Application – Cover Letter – Résumé Preparation – Internship Application **Grammar & Vocabulary:** 'If' Conditionals – Infinitives – Gerunds - Compound Nouns.

UNIT 5 REPORT WRITING **9**

Listening: Viewing a Model Group Discussion **Speaking**: Participating in a Group Talk –

Reading: Cause and Effect Essays – Business Letters **Writing:** Types of Reports - Report Format - Industrial Accident Report - Industrial Visit Report – Feasibility Report - Designing and Reporting Surveys – Writing Discursive Essays **Grammar & Vocabulary:** Reported Speech – Idioms and Phrases.

TOTAL: 45 PERIODS

TEXT BOOK:

1. 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited .2019.

REFERENCES:

1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level2, Student's Book) Cambridge University Press, New Delhi: 2017.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook , Oxford University Press, 2020.
3. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

e. RESOURCES :

1. www.eslgold.com
2. www.usingenglish.com

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

CO1	Read for gathering and understanding information using narrative techniques.
CO2	Develop and demonstrate listening skills for academic and professional purposes.
CO3	Apply apt vocabulary and construct grammatically correct sentences in professional situations.
CO4	Face interviews with communicative competence and confidence with a good knowledge of career skills.
CO5	Enhance writing skills for essays and for preparing reports.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					1	3			2	3		1		
CO 2					1	3			2	3		1		
CO 3		1			1	3			2	3		1		
CO 4					1	3			2	3		1		
CO 5					1	1			2	3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MAT23	VECTOR CALCULUS AND COMPLEX ANALYSIS (Common to B.E – CE and ME Programmes)	L	T	P	C
		3	1	0	4

Pre-requisites : Matrices and Calculus

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.

UNIT 1 DIFFERENTIATION OF VECTORS 9+3

Scalar and vector valued functions – gradient, tangent plane – directional derivative – divergence and curl – scalar and vector potentials – Statement of vector identities – Simple problems.

UNIT 2 INTEGRATION OF VECTORS 9+3

Line, surface and volume integrals – Statement of Green's, Stoke's and Gauss divergence theorems – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

UNIT 3 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 4 TAYLOR'S SERIES AND LAURENT'S SERIES 9+3

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula(excluding proof) – Zeros, Singularities -Taylor's and Laurent's series expansions.

UNIT 5 RESIDUES 9+3

Residues – Calculation of residues - Cauchy's residue theorem(excluding proof) – Application of residue theorem to evaluate real definite integrals.

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016

REFERENCES:

1. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition,Khanna Publishers, New Delhi, 2014
2. Veerarajan T., "Engineering Mathematics (I Year)", 3 rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2012.

e-Resources:

1. https://nptel.ac.in/courses/111105122. A course on Integral and vector calculus by Prof.Hari Shankar Mahato,IIT,Kharagpur.
2. https://nptel.ac.in/courses/111103070. A course on Complex Analysis,by Prof.P.A.S.Sree Krishna,IIT,Guwahati.

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

CO1 Compute gradient, directional derivative by vector differentiation.
CO2 Determine line integrals, surface integrals and volume integrals by vector integration.
CO3 Construct analytic functions and transform the analytic functions from one domain to another using conformal mapping.
CO4 Classify singularities, obtain Taylor's series and Laurent's series for analytic functions.
CO5 Compute complex integrals using Cauchy's Residue theorem.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2								1		
CO 2	3	3	2	2								1		
CO 3	3	3	2	2								1		
CO 4	3	3	2	2								1		
CO 5	3	3	2	2								1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22PHT21	MATERIALS SCIENCE (Common to B.E – CE and ME Programmes)	L	T	P	C
		3	0	0	3

Prerequisites : Engineering Physics

Preamble

Materials Science is a significant research area that involves in search of novel materials with the required qualities, and to understand the concept of acoustics, thermal Physics, elasticity, superconducting and new engineering materials.

UNIT 1 ACOUSTICS **9**

Introduction-Classification of Sound-Characteristics of Sound-Loudness Weber Fechner law-units of loudness-Decibel-Acoustics of buildings-Reverberation-Reverberation time-Sabine's formula for Reverberation time-Growth and Decay Method-Absorption Coefficient-Determination of Absorption Coefficient-Factors affecting Acoustics of Buildings.

UNIT 2 THERMAL PHYSICS **9**

Introduction-Modes of Heat transfer-Thermal Conductivity-Newton's law of Cooling-Determination of Thermal conductivity-Searle's method-Lee's Disc method-Radial flow of Heat-Rubber tube method-Thermal conductivity of a rubber tube-Heat conduction through a compound media(Series and parallel).

UNIT 3 ELASTICITY **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 beam-Bending moment-Cantilever, Young's Modulus by Uniform and non-Uniform bending: theory and Experiment-I-shaped girders.

UNIT 4 SUPERCONDUCTING MATERIALS **9**

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

UNIT 5 NEW ENGINEERING MATERIALS **9**

Metallic glasses: Preparation, properties and applications – Shape memory alloys (SMA): Characteristics, properties of Ni-Ti alloy, applications – Nanomaterials – Preparation – Pulsed laser deposition – Sol-Gel technique– Applications.

Total: 45

TEXT BOOKS:

1. Kasap S.O., "Principles of Electronic Materials and Devices", 3rd Edition, Tata McGraw-Hill 2007.
2. Palanisamy P.K, "Materials Science", 2nd Edition, Scitech publications (India) Pvt. Ltd., Chennai, 2007.

REFERENCES:

1. Balasubramaniam R, "Callister's Materials Science and Engineering", 2nd Edition, Wiley-India 2014.
2. Charles P. Poole and Frank J.Owens, "Introduction to Nanotechnology", 1st Edition, Wiley, New Delhi, 2007.
3. Bhattacharya D.K. and PoonamTandon "Engineering Physics",2nd Edition,Oxford University press. Senthilkumar.G, "Engineering Physics-I" New Edition VRB Publishers Pvt.Ltd,2013-2014.

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

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

CO1	Understand the principles of acoustics and the factors involved in construction of buildings.
CO2	Demonstrate the thermal conductivity of a material by Lee's Disc and Searle's method, and thermal conduction through compound media.
CO3	Discuss the basics of elasticity and the methods of measuring its parameters.
CO4	Describe the concept of Superconductivity by BCS theory along with their Applications.
CO5	Explain the preparation and properties of metallic glasses, Shape memory alloys and Nanomaterial using PLD,Sol-Gel methods.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	1	1	1	1	1			1	1	1		
CO2	3	2	1	1	1	1	1			1	1	1		
CO3	3	2	1	1	1	1	1			1	1	1		
CO4	3	2	1	1	1	1	1			1	1	1		
CO5	3	2	1	1	1	1	1			1	1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22CST11	PYTHON PROGRAMMING (Common to all B.E/B.Tech Programmes)	L	T	P	C
		3	0	0	3

Pre-requisites : Nil

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.

UNIT 1 COMPUTING FUNDAMENTALS 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT 2 INTRODUCTION TO PYTHON 9

Python interpreter, data types: int, float, boolean, string, and list; variables, expressions, statements, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT 3 CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT 4 LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT 5 FILES, MODULES AND PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages, Introduction to Pygame tool; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

Total : 45

TEXT BOOKS:

1. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, 2017.
2. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

REFERENCES:

1. E Balagurusamy," Problem Solving and Python Programming", McGraw Hill Education, 2018
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1stEdition, Notion Press, 2021.

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.

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

CO1	Use the basics of algorithmic problem solving techniques (pseudo code, flow chart, language basics) for a given problem.
CO2	Apply suitable python conditional and looping statements to solve a given problem.
CO3	Define Python functions and use function calls to solve problems.
CO4	Use Python data structures (lists, tuples, and dictionaries) to represent complex data.
CO5	Create python packages, modules and files for a given scenario.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2	2	1						1	1		
CO2	3	2	2	2	1						1	1		
CO3	3	2	2	2	1						1	1		
CO4	3	2	2	2	1						1	1		
CO5	3	2	2	2	1						1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET21	ENGINEERING MECHANICS (Common to B.E – CE and ME Programmes)	L	T	P	C
		3	1	0	4

Pre-requisites : Engineering physics

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.

UNIT 1 BASICS AND STATICS OF PARTICLES 9+3

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and Triangular laws of forces — Vectorial representation of forces 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 9+3

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 – Analysis of trusses using method of joints - Equilibrium of Rigid bodies in three dimensions.

UNIT 3 PROPERTIES OF SURFACES AND SOLIDS 9+3

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 byusing standard formulae. Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia – Polar moment of inertia – Radius of gyration - Mass moment of inertia – Mass moment of inertia for prismatic, cylindrical and spherical solids from first principle.

UNIT 4 FRICTION 9+3

Friction force – Types of friction - Laws of sliding friction –Applications of friction in machines - Wedge friction, Ladder friction, Screw friction, Belt friction.

UNIT 5 DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Displacements, Velocity and acceleration, their relationship – Relative motion –Work Energy Equation– Impulse and Momentum - Translation and Rotation of rigid bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. Beer F.P et.al., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 10th Edition, TataMcGraw 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. Meriam J. L., Kraige L. G. and Bolton J. N., "Engineering Mechanics SI Version (Volume 1 and 2)" , 8th Edition, Wiley, 2017.
3. Kottiswaran N., "Engineering Mechanics Statics and Dynamics", 10th Edition, Sri Balaji Publications Pvt.Ltd., 2013.

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

CO1 Analyze the static equilibrium of particles under the influence of forces.
CO2 Draw free body diagrams and to solve problems related to the static equilibrium of rigid bodies.
CO3 Locate the centroid of plane areas and centre of mass of solids and to compute moment of inertia.
CO4 Analyze the influence of friction on the equilibrium of bodies.
CO5 Analyze the equilibrium of particles subjected to dynamic forces and to solve problems related to the general plane motion of rigid bodies.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2									2		
CO 2	3	2	1							3		2		
CO 3	3	2	1									1		
CO 4	3	3	2									2		
CO 5	3	3	2									2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22HST21	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT 1 WEAVING AND CERAMIC TECHNOLOGY **3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT 2 DESIGN AND CONSTRUCTION TECHNOLOGY **3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT 3 MANUFACTURING TECHNOLOGY **3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT 4 AGRICULTURE AND IRRIGATION TECHNOLOGY **3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT 5 SCIENTIFIC TAMIL & TAMIL COMPUTING **3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total : 15

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொழியியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22PHL21	PHYSICS AND CHEMISTRY LABORATORY - II	L	T	P	C
	(Common to all B.E/B.Tech Programmes)	0	0	2	1

Preamble

This course aims to impart knowledge in the determination of the physical parameters such as young's modulus, band gap, Co-efficient of viscosity, thickness of thin wire and Rigidity modulus of wire. This course also aims to impart the significance and estimation of DO and Cl^- content in water sample by titrimetric method. Amount of Na^+, $Ba^{2+}$and acid with electroanalytical techniques such as flame photometry, conductometry and pH meter in the aqueous solutions has been quantitatively analyzed.

PHYSICS LABORATORY II
LIST OF EXPERIMENTS

1. Determination of Young's modulus by Uniform bending method.
2. Determination of bandgap of semiconductors.
3. Determination of co-efficient of viscosity by Poiseuille's method.
4. Determination of thickness of thin wire by Air wedge method.
5. Determination of rigidity modulus-torsion pendulum.

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. Estimation of dissolved metal ions present in wastewater using flame photometer.
4. Conductometric precipitation titration of $BaCl_2$ vs Na_2SO_4 using conductivity meter.
5. Determination of acid strength in waste water using pH meter.

Total: 45

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

CO1 Experiment and determine the physical characteristics of given solid materials using Young's modulus-Uniform bending method, Air wedge and Torsion Pendulum

CO2 Experiment and determine the band gap energy of a given semiconducting material using Zener diode.

CO3 Experiment and determine the physical characteristics of a given liquid using Poiseuille's method.

CO4 Experiment and estimate the amount of dissolved oxygen by Winkler's method and Chloride content by Mohr's method.

CO5 Analyse the concentration of metal ions and acid present in the wastewater with the aid of Flame photmeter, Conductivity meter and pH meter.

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1		3		1	1		1	1	1	1		
CO2	2	1		3		1	1		1	1	1	1		
CO3	2	1		3		1	1		1	1	1	1		
CO4	2	1		3		1	1		1	1	1	1		
CO5	2	1		3		1	1		1	1	1	1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High)

22CSL11	PYTHON PROGRAMMING LABORATORY (Common to all B.E/B.Tech Programmes)	L T P C 0 0 2 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.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
   (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions
   (exchange the values of two variables, circulate the values of n variables, distance between two points)
3. Scientific problems using Conditionals and Iterative loops.
   (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples.
   (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries.
   (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions.
   (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings.
   (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries
   Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling
10. Developing a game activity using Pygame like bouncing ball, car race

SOFTWARE

- Python 3 interpreter / open source IDE
- Raptor Tool
- Libre Office Packages

Total: 45

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

1. Design flowcharts using Raptor.
2. Develop programs using expressions and Control statements in Python.
3. Develop programs using functions, packages for a given problem..
4. Process compound data using Python data structures
5. Utilize Python packages in developing software applications.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	2	3					1			1		
CO2	2	2	2	3					1			1		
CO3	2	2	2	3					1			1		
CO4	2	2	2	3					1			1		
CO5	2	2	2	3					1			1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22CSL11 **PYTHON PROGRAMMING LABORATORY** **L T P C**

(Common to all B.E, B.Tech Programmes) **0 0 3 1**

(For the students admitted from AY 2024-25)

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.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
   (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions
   (exchange the values of two variables, circulate the values of n variables, distance between two points)
3. Scientific problems using Conditionals and Iterative loops.
   (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples.
   (Items present in a library/Components of a car/ Materials required for construction of a building – operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries.
   (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions.
   (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings.
   (reverse, palindrome, character count, replacing characters)
8. Implementation of searching algorithms using linear and binary search technique.
9. Implementation of sorting algorithms using selection sort and insertion sort method.
10. Implementing programs using written modules and Python Standard Libraries
    Libraries (pandas, numpy. Matplotlib, scipy)
11. Implementing real-time/technical applications using File handling.
12. Developing a game activity using Pygame like bouncing ball, car race.

SOFTWARE

- Python 3 interpreter / open source IDE
- Raptor Tool
- Libre Office Packages

TOTAL: 45

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

CO1	Design flowcharts using Raptor.
CO2	Develop programs using expressions and Control statements in Python.
CO3	Develop programs using functions, packages for a given problem.
CO4	Process compound data using Python data structures
CO5	Utilize Python packages in developing software applications.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	2	3					1			1		
CO2	2	2	2	3					1			1		
CO3	2	2	2	3					1			1		
CO4	2	2	2	3					1			1		
CO5	2	2	2	3					1			1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL21	COMPUTER AIDED DRAFTING AND MODELING LABORATORY	L	T	P	C
		0	0	2	1

(Common to B.E – CE and ME Programmes)

Pre-requisites: Engineering Graphics

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.

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 and Title Block with necessary text and projection symbol.
2. Drawing a Projection of Straight lines inclined to both the principal planes.
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 bedrooms, kitchen, hall, etc.)

Total : 45

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.

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

CO1 Develop the 2D sketches for the given conditions using drafting packages.
CO2 Sketch the orthographic views for the given isometric view of solids.
CO3 Create 3D models of simple engineering components.
CO4 Develop multiple views from the solid modeled.
CO5 Draw the plan and elevation of residential buildings.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1	1				3	3		2		
CO 2	3	2	1	1	1				3	3		2		
CO 3	3	2	1	1	1				3	3		2		
CO 4	3	2	1	1	1				3	3		2		
CO 5	3	2	1	1	1				3	3		2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCT03	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to all B.E/B.Tech Programmes)	L	T	P	C
		2	0	0	0

Preamble

The study of biodiversity reflects the level of national interest in natural resources and heritage, which is considered as an important part of a country's wealth. As India is one of the world's 12 giant diversity hubs, we need to focus on understanding, preserving and utilizing the biodiversity of our biological resources. Environmental protection is an important issue for today's society, as scientific research provides evidence of increased global warming, ozone depletion and increased pollution. Engineers need to learn the importance of green synthesis in the design, development and evaluation of structures, devices and systems to provide practical solutions to the problems caused by the pollution and depletion of natural resources.

UNIT 1 NATURAL RESOURCES, ECOSYSTEM AND BIODIVERSITY *6*

Forest Resources – use and over exploitation – Water Resources – use and over utilization – Dams – benefits and problems – Ecosystem – structure and function – Biodiversity – types – threats to biodiversity – Biodiversity conservation–In-situ and Ex-situ – Role of an individual in conservation of natural resources.

UNIT 2 ENVIRONMENTAL POLLUTION **6**

Definition – causes, effects and control measures – Air Pollution, Water Pollution, Soil Pollution – Solid waste – methods of disposal – sanitary landfill, incineration and composting – Environmental Impact Assessment and ISO 14000.

UNIT 3 E-WASTE AND ITS MANAGEMENT *6*

E-Waste – sources of e-waste – hazardous substances in e-waste – effects of e-waste on environment and human health – need for e-waste management – disposal treatment methods of e-waste – Global scenario of e-waste – e-waste in India- case studies.

UNIT 4 SOCIAL ISSUES AND THE ENVIRONMENT *6*

Social issues – Sustainable development – Water conservation – rain water harvesting. Disaster Management – floods, earthquake, cyclone and landslides. Role of IT in environment and human health.

UNIT 5 GREEN CHEMISTRY *6*

Green Chemistry – twelve principles of green chemistry – Importance of green synthesis – Green synthesis – dimethyl carbonate – Bio-catalysts – extraction of gold – Applications of green synthesis.

Total : 30

TEXT BOOKS:

1. Environmental Science, 5th Edition. P. N. Palanisamy, P. Manikandan, A. Geetha, K. Manjula Rani, V. N. Kowshalya, Pearson India Education services Private Limited, 2020.
2. Environmental Science and Engineering, 2nd edition, Dr.T. Arun Luiz , V K publications, 2018.

REFERENCES:

1. Environmental Science and Engineering, 3rd reprint, Benny Joseph, McGraw Hill Education (India) Private Limited, New Delhi, 2015.
2. Engineering Chemistry, 1st Impression, K. Sesha Maheswaramma, Mridula Chugh, Pearson India Education Services Private Limited, 2016.
3. Introduction to Environmental Engineering and Science, 2nd edition, Gilbert M. Masters, Prentice Hall of India Private Limited, 2015.

e-Resources:

1. https://www.digimat.in/nptel/courses/video/105105169/L01.html , "Electronic waste management-issues and challenges"- Prof. Brajesh Kumar Dubey, Department of Civil Engineering, IIT Kharagpur.
2. https://archive.nptel.ac.in/courses/105/103/105103205/, "Municipal solid waste management"- Prof. Ajay Kalamdhad, Department of Civil Engineering, IIT Guwahati.

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

CO1	Recognize the biodiversity threats, overexploitation of forest and overutilization of water to conserve biodiversity.
CO2	Analyze sources, impacts, air and water pollution control measures and solid waste management to maintain a green environment.
CO3	Identify the Environmental impacts of e-waste and its management.
CO4	Explain human health, environment and disaster management through information technology.
CO5	Apply the principles of green chemistry to green synthesis for a sustainable environment.

COs\POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	1	1	1	2	3	2	1	1	1	2		
CO2	3	2	1	1	1	2	3	2	1	1	1	2		
CO3	3	2	1	1	1	2	3	2	1	1	1	2		
CO4	3	2	1	1	1	2	3	2	1	1	1	2		
CO5	3	2	1	1	1	2	3	2	1	1	1	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET31	MANUFACTURING PROCESSES	L	T	P	C
		3	0	0	3

Pre-requisites : Nil

Preamble

Introducing the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

UNIT 1 METAL CASTING PROCESSES 9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting; Defects in Sand casting

UNIT 2 JOINING PROCESSES 9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT 3 METAL FORMING PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

UNIT 4 SHEET METAL PROCESSES 9

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning– Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming

UNIT 5 MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Moulding of thermoplastics – working principles and typical applications – injection moulding – Plunger and screw machines – Compression moulding, Transfer Moulding – Typical industrial applications – Introduction to blow moulding –Rotational moulding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics

Lecture : 45 Total : 45

TEXT BOOKS:

1. Kaushish J.P, “Manufacturing Processes”, 2nd edition, Prentice Hall India Learning Private Limited, 2010
2. Lindberg, “Processes and Material for Manufacture”, Pearson Education India, 3rd edition,2015.
3. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2018.
4. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2018

REFERENCES:

1. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2014.Practices", Prentice Hall of India, 1998
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4 th Edition, TMH-2013

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

CO1 Explain different metal casting processes, associated defects, merits and demerits CO2
CO2 Compare different metal joining processes.
CO3 Summarize various hot working and cold working methods of metals.
CO4 Explain various sheet metal making processes.
CO5 Distinguish various methods of manufacturing plastic components.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		2									1	2	
CO 2	3		2									1	2	
CO 3	3		2									1	2	
CO 4	3		2									1	2	
CO 5	3		2	2							1	1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET32	FLUID MECHANICS AND MACHINERY	L	T	P	C
		3	1	0	4

Pre-requisites : Engineering Physics, Engineering Mechanics

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.

UNIT 1 FLUID CHARACTERISTICS AND DYNAMICS OF FLUID FLOW 9+3

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 (Qualitative Treatment)

UNIT 2 FLUID FLOW TYPES AND FLOW THROUGH PIPES 9+3

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+3

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) – Case Studies

UNIT 4 HYDRAULIC TURBINES 9+3

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+3

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 – Gear pumps – Lobe pumps – Vane pumps – Constructional details, Working principles. Special type pumps, House hold application pumps.

Lecture : 45,Tutorial : 15 Total : 45

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.

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

CO1 Analyze the dynamics of fluid flow and summarize the flow characteristics.
CO2 Identify the flow characteristics and solve the problems caused in flow through pipes.
CO3 Apply the principles of dimensional analysis and model analysis to fluid flow related problems.
CO4 Analyze critically the performance of turbines.
CO5 Apply the energy exchange process in pumps.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	-	-	-	-	-	-	-	-	2	-	3
CO 2	3	2	2	-	-	-	-	-	-	-	-	1	-	3
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	-	3
CO 4	3	3	2	-	-	3	-	-	-	-	-	2	-	3
CO 5	3	2	2	-	-	3	-	-	-	-	-	1	-	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEC31	ELECTRICAL DRIVES AND CONTROL	L	T	P	C
		3	0	2	4

Pre-requisites : Electrical Machines, Power Electronics

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.

UNIT 1 ELECTRICAL DRIVES **9+3**

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+3**

DC Shunt motor, DC Series motor and Induction motors, Speed-Torque characteristics and braking characteristics of DC shunt, Series and Induction motors.

UNIT 3 STARTING METHODS **9+3**

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, Autotransformer Starter, Star-Delta Starter and Rotor Resistance Starter.

UNIT 4 CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF DC DRIVES **9+3**

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+3**

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.

Lecture : 45, Practical : 15, Total : 60

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, 2012
2. Singh. M.D., K.B. Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2006
3. Pratab. H., “Art and Science and Utilization of Electrical Energy”, Dhanpat Rai and Sons,2017

e-Resources:

1. http://www.nptelvideos.in/2012/11/advanced-electric-drives.html, Advanced Electrical Drives, Advanced Electric Drives, NPTEL Videos, IIT Delhi.
2. https://archive.nptel.ac.in/courses/108/104/108104140/ Introduction to Electric Drives, NPTEL Videos, IIT Delhi.

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

CO1	Identify and explain the types and selection of rating of electrical drives.
CO2	Analyze the speed-torque characteristics and braking characteristics of electrical drives for DC shunt, series and induction motors.
CO3	Illustrate the types and characteristics of DC and AC motor starters.
CO4	Compare and contrast the conventional and solid-state speed control of DC and AC drives.
CO5	Experiment and test the speed control of DC and AC motors and the performance analysis of DC and AC motor drives.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1										
CO 2	3	2	1	1										
CO 3	3	2	1	1										
CO 4	3	2	1	1										
CO 5	3	2	1	1										

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET33	ENGINEERING THERMODYNAMICS	L	T	P	C
		3	1	0	4

Pre-requisites : Basics Knowledge on Engineering Physics

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.

UNIT 1 THERMODYNAMIC SYSTEMS AND FIRST LAW 9+3

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 AND ENTROPY 9+3

Second law of thermodynamics - Kelvin Planck 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 9+3

Properties of pure substances – Steam formation and its thermodynamic properties p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces- Determination of dryness fraction- Calculations of work done and heat transfer in non-flow and flow processes using Steam Table and Mollier Chart. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles.

UNIT 4 IDEAL, REAL GASES AND THERMODYNAMIC RELATIONS 9+3

Properties of ideal and real gases-comparison, Equations of state, Avagadro's Law, Vander Waal's equation, Reduced Properties, Compressibility factor, Principle of Corresponding States, Generalized Compressibility chart.

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

UNIT 5 PSYCHROMETRY 9+3

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.

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. P K Nag, "Engineering Thermodynamics", 6th Edition, McGraw-Hill Education (India) Private Limited, 2017, New Delhi.
2. E. Rathakrishnan, "Fundamentals of Engineering Thermodynamics", 2nd Edition, New Delhi: PHI Learning, 2015.

REFERENCES:

1. R.K. Rajput, “A Textbook of Engineering Thermodynamics”, 5th Edition, Lakshmi Publications Pvt. Ltd., New Delhi, 2017.
2. Cengel. Y and M.Boles, "Thermodynamics - An Engineering Approach", 8th Edition, McGraw Hill Education (India), 2015.
3. Natarajan E, “Engineering Thermodynamics: Fundamentals and Applications", 2nd Edition, Anuragam Publications, Chennai, 2014.

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

CO1	Determine the energy transfer and change in properties of ideal gas or steam in thermodynamically open systems during different thermodynamic processes.
CO2	Apply the second law of thermodynamics for performance of thermal systems and its applications.
CO3	Identify the properties of pure substances and explain the working of steam power cycles.
CO4	Comprehend the thermodynamic relations, ideal and real gas behaviors.
CO5	Analyze the different psychrometric processes and their applications.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2									1		3
CO 2	3	2	2			3						1		3
CO 3	3	2	2				1					1		2
CO 4	3	2	2									1		2
CO 5	3	2	2			3	2					1		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET34	KINEMATICS OF MACHINERY	L	T	P	C
		2	1	0	3

Pre-requisites: Engineering Mechanics & Mathematics.

Preamble

Kinematics of Machinery is the branch of Theory of machines and is one of the core and traditional subjects in the Mechanical Engineering curriculum. It deals with the study of various mechanisms and determinining relative motion between various parts of a machine. To develop a capability to design a system with practical limitations. It emphasizes importance on kinematic analysis of mechanisms and cam profiles. Also it highlights kinematics of gear trains and the effects of friction in transmission and machine components.

UNIT 1 BASICS OF MECHANISMS 6+3

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom- Mobility – Kutzbach criterion - Grubler's criterion – Grashof's law – Kinematic inversions of four-bar chain and slider crank chains and their applications – Quick return mechanisms – Mechanical advantage– Transmission Angle – Straight line generators (Basics only).

UNIT 2 KINEMATICS OF LINKAGE MECHANISMS 6+3

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Relative velocity method and Instantaneous centre method and Klein's construction – Analytical method – Kinematic analysis of simple mechanisms–Coincident points– Coriolis component of Acceleration.

A simple fabrication of any one simple mechanism (Not for Examination).

UNIT 3 KINEMATICS OF CAM MECHANISMS 6+3

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 – Specified contour cams – Circular arc and tangent cams (Qualitative only).

UNIT 4 GEARS AND GEAR TRAINS 6+3

Spur gear terminology and definitions – Law of toothed gearing – Involutes and cycloidal tooth profiles – Gear tooth action – Contact ratio – Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, Train value – Parallel axis gear trains – Epicyclic Gear Trains- Sun and planet wheel.

UNIT 5 FRICTION IN MACHINE ELEMENTS 6+3

Surface contacts – Friction clutches - Single plate, multi plate, cone and centrifugal clutches – Belt drives - flat and V belts – Length of the belt - Driving tensions- Condition for maximum power - Rope drives.

Lecture : 30, Tutorial : 15, Total : 45

TEXT BOOKS:

1. Rattan S.S, "Theory of Machines", 5th Edition, McGraw-Hill Education, 2019.
2. Khurmi, R.S, Gupta. J.K, "Theory of Machines", 14th Edition, S.Chand & Company Pvt Ltd, 2020.

REFERENCES:

1. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition, Affiliated EastWest Pvt.Ltd., New Delhi, 2020.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 5th Edition, Oxford University Press, 2017.
3. Thomas Bevan, "Theory of Machines", 3rd Edition, Pearson Education India, 2009.

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

CO1 Demonstrate the fundamentals of mechanisms.
CO2 Analyze various plane mechanisms for displacement, velocity and acceleration at any point in a moving link.
CO3 Develop Cam Profiles for the given follower motions.
CO4 Solve problems on gears and gear trains.
CO5 Examine friction in machine elements.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2								2	3	
CO 2	3	2	2	2						3		2	3	
CO 3	3	2	2	2						3		2	3	
CO 4	3	2	2	2								2	3	
CO 5	3	2	2	2								2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL31 MANUFACTURING PROCESSES LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites : Workshop Practices Laboratory

Preamble

Manufacturing Processes 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.

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. External thread cutting, grooving and knurling
8. Drilling, boring and internal thread cutting
9. Multiple operations using capstan / turret lathe
10. Introduction to machining cost calculations

Total : 45

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

CO1 Prepare sand moulds for various patterns.
CO2 Fabricate components using gas and spot welding processes
CO3 Perform turning, external thread cutting, taper boring and knurling operations using lathe.
CO4 Conduct drilling, boring and internal/external thread cutting operations using lathe.
CO5 Perform multiple operations using capstan/turret lathe.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3			3	3		2	2	
CO 2	3	2	2	2		3			3	3		2	2	
CO 3	3	2	2	2		3			3	3		2	2	
CO 4	3	2	2	2		3			3	3		2	2	
CO 5	3	2	2	2		3			3	3		2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL32 FLUID MECHANICS AND MACHINERY LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Engineering Mechanics

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.

LIST OF EXPERIMENTS

1. (i) Calculation of the rate of flow using Rota Meter.
   (ii) Determination of friction factor for a given set of pipes.
2. Determination of the coefficient of discharge of given Orifice Meter.
3. Determination of the coefficient of discharge of given Venturi Meter.
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

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

CO1 Calibrate flow measuring devices such as venturimeter, orifice meter, etc.
CO2 Operate fluid flow equipment and instruments.
CO3 Analyze the various losses during flow through pipes.
CO4 Experiment and analyze the performance of impulse and reaction turbines.
CO5 Conduct performance analysis of rotary and reciprocating pumps.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3			2	2		1		2
CO 2	3	2	2	2		3			2	2		1		2
CO 3	3	2	2	2		3			2	2		1		2
CO 4	3	2	2	2		3			2	2		1		2
CO 5	3	2	2	2		3			2	2		1		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCL04 **ENGLISH FOR PROFESSIONALS** **L T P C**
(Third / Fourth Semester) **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.

UNIT 1 LISTENING **5**

Listening to Casual Conversation- Note-Taking on TED Talks – Summarizing

UNIT 2 READING **7**

Poem - Robert Frost's Road Not Taken- Decision Making- Biographies of Famous Personalities - Reading and Note Making on News Articles

UNIT 3 WRITING **5**

Letter Writing - Letters Seeking Permission- Letters Seeking Apology - Letters Requesting Certificates – Analytical Writing

UNIT 4 SPEAKING **9**

Watching Presentations - Presentation Techniques - Group Presentation - Group Discussion

UNIT 5 VERBAL ABILITY **4**

Parajumbles - Sentence Completion - Identifying Common Errors

TOTAL: 30 PERIODS

REFERENCES:

1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Meenakshi Raman and Sangeetha Sharma., "Technical Communication: English Skills for Engineers" Oxford University Press, 1st Edition, New Delhi, 2008.

e. RESOURCES :

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. http://learnenglishteens.britishcouncil.org/skills/reading
4. https://www.bbc.com/

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

CO1 Analyze the given listening material and answer the questions correctly employing listening techniques.

CO2 Analyze the given reading material and answer the questions correctly employing reading techniques.

CO3 Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of essays and letters.

CO4 Take part effectively in group discussion, conforming to professional norms and to give extemporaneous presentation.

CO5 Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

Cos/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					3					3				
CO 2										3				
CO 3									3	3		1		
CO 4									3	3		1		
CO 5										3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCL04 **ENGLISH FOR PROFESSIONALS** **L T P C**
(III / IV Semester) **0 0 2 0**
(Students admitted during 2023-2024 onwards)

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.

UNIT 1 LISTENING **5**

Listening to Casual Conversation- Note-Taking on TED Talks – Summarizing

UNIT 2 READING **7**

Reading for gist - Biographies of Famous Personalities - Reading and Note Making on News Articles

UNIT 3 WRITING **5**

Letter Writing - Seeking Permission- Seeking Apology - Letters Requesting Certificates – Analytical Writing and Issue based writing

UNIT 4 SPEAKING **9**

Presentation Techniques - Presentation with visual aids – Extempore and Impromptu talk

UNIT 5 VERBAL ABILITY **4**

Parajumbles - Sentence Completion - Identifying Common Errors

TOTAL: 30 PERIODS

REFERENCES:

1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Meenakshi Raman and Sangeetha Sharma., "Technical Communication: English Skills for Engineers" Oxford University Press, 1st Edition, New Delhi, 2008.

e. RESOURCES :

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. http://learnenglishteens.britishcouncil.org/skills/reading
4. https://www.bbc.com/

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

CO1 Analyze the given listening material and answer the questions correctly employing listening techniques.

CO2 Analyze the given reading material and answer the questions correctly employing reading techniques.

CO3 Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of essays and letters.

CO4 Take part effectively in group discussion, conforming to professional norms and to give extemporaneous presentation.

CO5 Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

Cos/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					3					3				
CO 2										3				
CO 3									3	3		1		
CO 4									3	3		1		
CO 5										3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MAT44 DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS L T P C

(B.E Mechanical Engineering Programme in Fourth Semester) 3 1 0 4

Pre-requisites: 22MAT13 – Matrices and Calculus, 22MAT23 – Vector Calculus and Complex Analysis

Preamble

This course aims at providing the necessary basic concepts of order differential equations, partial differential equations and numerical techniques. Computational methods aim for getting numerical solution for algebraic, transcendental equations, boundary value problems and initial value problems.

UNIT 1 ORDINARY DIFFERENTIAL EQUATIONS 9+3

Linear higher order differential equations with constant coefficients – Particular Integrals for the types: $e^{ax}, cosax\ or\ sinax,\ x^n$ – Method of variation of parameters – Applications of differential equations: Simple harmonic motion – bending of beams (Differential equations and associated conditions need to be given).

UNIT 2 PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations – Solving partial differential equations of first order: Clairaut's form, Lagrange's linear equation – Solving Linear partial differential equations of second and higher order with constant coefficients of homogeneous type - Particular Integrals for the types: $e^{ax+by}, x^m y^n, (ax+by)\ or\ cos\ cos\ (ax+by)$.

UNIT 3 SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

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 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9+3

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

UNIT 5 NUMERICAL SOLUTION TO PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference techniques for the solution of One Dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method-Two dimensional Laplace equations on rectangular domain.

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. Grewal. B.S., "Numerical Methods in Engineering and Science", 10th Edition, Khanna Publishers, New Delhi, 2014.
2. Grewal B.S., "Higher Engineering Mathematics" 44th Edition, Khanna Publishers, New Delhi, 2014

REFERENCES:

1. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 7thEdition, McGraw Hill Education India Private Limited,2016.
2. Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" 7th Edition, Pearson Education India, 2013.
3. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26thReprint, New Delhi, 2016

e-Resources:

1. https://archive.nptel.ac.in/courses/111/106/111106100/01 ," Introduction to Ordinary Differential Equations", Module-IV, Dr. Srinivasa Rao Manam, Department of Mathematics, Indian Institute of Technology , Madras.
2. https://archive.nptel.ac.in/courses/111/106/111106100/21, " Differential Equations", Module-IV, Dr.Srinivasa Rao Manam, Department of Mathematics, Indian Institute of Technology , Madras.
3. https://archive.nptel.ac.in/courses/127/106/127106019/10 , "Numerical Methods for Engineers" Prof. NiketKaisare , Department of Mathematics, Indian Institute of Technology , Madras.

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

CO1 Solve linear differential equations with constant coefficients and apply them in solving real world problems.

CO2 Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and higher order with constant coefficients.

CO3 Compute the real root of the algebraic and transcendental equations and solve the system of linear equations numerically.

CO4 Solve the ordinary differential equations using Taylor's series, Euler's method and Runge-Kutta method.

CO5 Compute the numerical solution for the Boundary value problems involving partial differential equations using implicit and explicit methods.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2								1		
CO 2	3	3	2	2								1		
CO 3	3	3	2	2								1		
CO 4	3	3	2	2								1		
CO 5	3	3	2	2								1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET41	MACHINING PROCESSES	L	T	P	C
		3	0	0	3

Pre-requisites : Manufacturing Processes

Preamble

Understanding the concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, grinding and allied machines and broaching, Computer Numerical Control (CNC) of machine tools and CNC Programming.

UNIT 1 THEORY OF METAL CUTTING 9

Mechanics of chip formation, single point cutting tool, forces in machining, Types of chip, cutting tools– nomenclature, orthogonal metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability.

UNIT 2 TURNING MACHINES 9

Centre lathe, constructional features, specification, operations — taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes- tool layout — automatic lathes: semi automatic — single spindle: Swiss type, automatic screw type — multi spindle:

UNIT 3 SHAPER, MILLING AND GEAR CUTTING MACHINES 9

Shaper — Types of operations. Drilling, reaming, boring, Tapping. Milling operations-types of milling cutter. Gear cutting — forming and generation principle and construction of gear milling, hobbing and gear shaping processes –finishing of gears.

UNIT 4 ABRASIVE PROCESS AND BROACHING 9

Abrasive processes: grinding wheel — specifications and selection, types of grinding process– cylindrical grinding, surface grinding, centreless grinding and internal grinding- Typical applications — concepts of surface integrity, broaching machines: broach construction — push, pull, surface and continuous broaching machines

UNIT 5 CNC MACHINING 9

Numerical Control (NC) machine tools — CNC types, constructional details, special features, machining centre, part programming fundamentals CNC — manual part programming — micromachining — wafer machining.

Lecture: 45, Total : 45

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2022
2. Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools", 3rd Edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCES:

1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
3. Roy. A.Lindberg, “Process and Materials of Manufacture,” Fourth Edition, PHI/Pearson Education 2006.

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

CO1	Discuss the mechanism of material removal processes
CO2	Describe the constructional and operational features of centre lathe and other special purpose lathes
CO3	Describe the constructional and operational features of shaper, planner, milling, drilling, sawing and broaching machines.
CO4	Explain the types of grinding and other super finishing processes apart from gear manufacturing processes.
CO5	Summarize numerical control of machine tools and write a part program.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		2									1	2	
CO 2	3		2									1	2	
CO 3	3		2				1			2		1	2	
CO 4	3		2	2							1	1	2	
CO 5	3		2									1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET42	STRENGTH OF MATERIALS	L	T	P	C
		3	1	0	4

Pre-requisites: Engineering Mechanics

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.

UNIT 1 STRESS, STRAIN AND DEFORMATION OF SOLIDS 9+3

Rigid bodies and deformable solids - Stresses– Types –Tension, Compression and Shear Stresses – Thermal stresses –Strain–Deformation of simple and compound bars – Poisson Ratio — Elastic constants – Volumetric strains - Strain energy due to axial loading - Stresses due to sudden loads.

Stresses on inclined planes – Principal stresses and principal planes – Analytical method and Mohr's circle method.

UNIT 2 TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9+3

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 DEFLECTION OF BEAMS 9+3

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 4 TORSION AND SPRINGS 9+3

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 5 THIN SHELLS, THICK SHELLS AND COLUMNS 9+3

Circumferential and longitudinal stresses and deformation in thin cylinders –Stress and deformation in thin spherical shells – Lame's theory – Stresses in thick cylinders - Stresses in thick spherical shells.

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

Lecture : 45, Tutorial : 15, Total : 60

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. Rajput R. K., "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 Book Co, NewYork, 2015.

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

CO1 Calculate the stresses developed and deformation in bars.
CO2 Explain the bending and shear stress distribution in beams.
CO3 Discuss the Macaulay's method and computation of slope and deflection in beams.
CO4 Identify and explain the torsional deformation in shafts and deflection in springs.
CO5 Analyze the deformation in pressure vessels.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2								1	3	
CO 2	2	2	2	2								1	2	
CO 3	2	2	2	2								1	2	
CO 4	2	2	2	2								1	2	
CO 5	3	3	2	2								1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET43	THERMAL ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites : Engineering Thermodynamics

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.

UNIT 1 INTERNAL COMBUSTION ENGINES 9

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.

Battery, Magneto and Electronic ignition system - Knocking - phenomena and control- Lubrication and Cooling systems – Performance calculation.

UNIT 2 GAS POWER CYCLES 9

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

UNIT 3 STEAM NOZZLES AND STEAM TURBINES 9

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.

UNIT 4 RECIPROCATING AIR COMPRESSOR 9

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 with intercooling –Work of multistage air compressor.

UNIT 5 REFRIGERATION AND AIR CONDITIONING 9

Refrigerants -Vapour compression refrigeration cycle and Performance calculation- Super heat and Sub cooling - Working principle of Vapour absorption system - Thermoelectric refrigeration (Description Only)

Air conditioning systems, concept of RSHF, GSHF and ESHF, Working principles of Summer, Winter, Split and Centralized AC systems - Simple cooling & heating load calculation

Cryogenic engineering: Introduction, Application, Cryo-coolers.

Lecture: 45, Total: 45

APPROVED DATA BOOKS: (Permitted for Semester Examination)

1. Khurmi.R.S, “Steam Table”, 9th Edition, S.Chand Publishers, 2019.
2. Kothandaraman.C.P., “Refrigeration Tables and Charts”, 6th Edition, New Age International Pvt. Ltd., New Delhi, 2020.

TEXT BOOKS:

1. Er. Rajput. R. K., “Thermal Engineering”, Eleventh Edition, Lakshmi Publications, New Delhi, 2023.
2. Kothandaraman C.P., Domkundwar.S, Domkundwar. A.V., “A Course in Thermal Engineering”, 6th Edition, Dhanpat Rai & Co. Pvt. Ltd., 2017.

REFERENCES:

1. Ballaney P.L., "Thermal Engineering", 25th Edition, Khanna Publishers, New Delhi, 2017.
2. Ganesan V., "Internal Combustion Engines", 4th Edition, McGraw-Hill Education Pvt Ltd., New Delhi, 2017.
3. Arora.C.P, "Refrigeration and Air Conditioning", 4th Edition, McGraw-Hill Education Pvt Ltd. New Delhi, 2020.

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

CO1 Identify the various components of IC engines and discuss their functions.
CO2 Apply thermodynamic concepts to different air standard cycles and solve problems.
CO3 Classify the nozzles & turbines and draw the velocity diagrams of simple turbines.
CO4 Analyze the performance of reciprocating air compressors.
CO5 Evaluate the cooling load requirements for conditioned space.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2			2				2		1		2
CO 2	3	2	2	2		3				3		1		3
CO 3	3	2	2	2		3				3		1		3
CO 4	3	2	2	2		3				3		1		3
CO 5	2	2	2			2				2		1		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET44	DYNAMICS OF MACHINERY	L	T	P	C
		2	1	0	3

Pre-requisites : Engineering Mechanics, Kinematics of machinery

Preamble

The objective of dynamics is analysis of the behavior of a given machine or mechanism when subjected to dynamic forces. The role of kinematics is to ensure the functionality of the mechanism, while the role of dynamics is to verify the acceptability of induced forces in parts.

UNIT 1 FORCE ANALYSIS **6+3**

Static force analysis of mechanisms – Inertia force and Inertia torque – D'Alembert's principle - Dynamic force analysis - Dynamic Analysis in Reciprocating Engines – Gas Forces - Equivalent masses - Bearing loads - Crank shaft Torque – Engine shaking Forces - Turning moment diagrams - Flywheels of engines.

UNIT 2 BALANCING OF MASSES **6+3**

Static and dynamic balancing - Balancing of rotating masses – Balancing of Several masses Rotating in different planes - Balancing of reciprocating masses-Balancing a single cylinder Engine – Primary and secondary unbalanced forces – Balancing Multi-cylinder inline – Firing order – Balancing machines.

UNIT 3 FREE VIBRATION **6+3**

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 and three rotor systems.

UNIT 4 FORCED VIBRATION **6+3**

Response of single DoF systems to periodic forcing - Harmonic Forcing – Forced vibration caused by unbalance - Support motion –Magnification factor - Transmissibility - Vibration isolation – Vibration Measurement.

UNIT 5 BRAKES AND GYROSCOPIC COUPLE **6+3**

Introduction – Materials of Brake lining-Types of Brake-Single block-Pivoted block-Double block-Simple band brake – Differential band brake-Band and Block brake-Internal Expanding Brake-Braking of a vehicle - Dynamometer – Types - Classification of absorption Dynamometer – Prony brake – Rope brake - Classification of transmission dynamometer.

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

Lecture : 30,Tutorial: 15, Total : 45

TEXT BOOKS:

1. Rattan, S.S, "Theory of Machines", 4th Edition, McGraw-Hill Education, 2015.
2. Ambekar A. G, "Mechanism and Machine Theory", 3rd Edition, Prentice Hall of India, New Delhi, 2014.

REFERENCES:

1. Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2015.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4th Edition, oxford University Press, 2014.
3. Balaguru, S, "Dynamics of Machinery", 4th Edition, Scitech Publication (India) Pvt. Ltd., 2015.

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

CO1 Solve problems related to vibration issues using force analysis in mechanical systems.
CO2 Explain balancing and procedures of the basic balancing.
CO3 Determine the natural frequency of continuous systems starting from general equation of displacement.
CO4 Analyze the undesirable effects of unbalance in rotors and engines and vibratory systems.
CO5 Demonstrate knowledge on the principles of governors and gyroscopes.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2								2	3	
CO 2	3	3	2	2						3		1	3	
CO 3	3	2	2	2								1	3	
CO 4	3	2	2	2						3		1	3	
CO 5	3	2	2	2								1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEC45 ENGINEERING MATERIALS AND METALLURGY

L	T	P	C
3	0	2	4

Pre-requisites : Manufacturing Processes

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.

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 – ASTM Standards for Different Mechanical Tests.

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.

Lecture : 45, Practical: 15, Total : 60

TEXT BOOKS:

1. Sidney H Avner, "Introduction to Physical Metallurgy", 2nd Edition, McGraw Hill Education India, 2017.
2. Srinivasan. R, "Engineering Materials and Metallurgy", 4th Edition, Vijay Nicole imprints Pvt Ltd, 2018.

REFERENCES:

1. William D. Callister, David G. Rethwisch, "Materials Science and Engineering", 10 th Edition, Wiley India Pvt. Ltd., 2020.
2. Rajput. R.K, "Engineering Materials and Metallurgy", 2 nd Edition, S. Chand Publishing, New Delhi, 2020.
3. Raghavan. V, "Material Science and Engineering" 6th Edition, PHI Learning Pvt Ltd, New Delhi, 2015.

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

CO1 Explain various reactions, microstructure and compositions in the phase diagrams.
CO2 Select appropriate heat treatment process for specific applications.
CO3 Identify and explain the composition, properties and applications of ferrous & non-ferrous metals.
CO4 Discuss the properties and applications of non-metallic materials.
CO5 Classify the various testing procedures to evaluate material properties.
CO6 To perform tension test, impact test, torsion test, deflection test and hardness test on given Specimens.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2							2		1	2	
CO 2	3	2	2							3		1	3	
CO 3	2	2	2									1	2	
CO 4	2	2	2									1	2	
CO 5	2	2	2	2								1	2	
CO 6	3	2	2	2		3			2	2		1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL41 **MACHINING PROCESSES LABORATORY**

L	T	P	C
0	0	2	1

Pre-requisites: Manufacturing Processes Laboratory

Preamble

To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in the industry

LIST OF EXERCISES

1. Contour milling using vertical milling machine.
2. Spur gear cutting in milling machine.
3. Helical Gear Cutting in milling machine.
4. Gear generation in hobbing machine
5. External Keyway cutting using Shaping machine.
6. Internal Keyway cutting using Slotting machine.
7. Plain Surface grinding
8. Cylindrical grinding
9. Tool angle grinding with tool and Cutter Grinder
10. Measurement of cutting forces in Milling / Turning Process

Total : 45

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

CO1 Find right tool for the machining of various contour operations
CO2 use different machine tools to manufacturing gears
CO3 Use different machine tools for surface finishing operations
CO4 Demonstrate the knowledge on force measurement using dynamometer
CO5 Select tool angles for various machining processes

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	3		1			2	1		1	3	
CO 2	3	2	2	3		1			2	1		1	3	
CO 3	3	2	2	3		1			2	1		1	3	
CO 4	3	2	2	3	2	1			2	1		1	3	
CO 5	3	2	2	3		1			2	1		1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL42 THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Engineering Thermodynamics

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.

LIST OF EXERCISES

Study

1. Study of Dynamometers.
2. Study of Steam generators.
3. Study of Steam turbines.

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. Valve timing and port timing diagrams.
4. Performance test on reciprocating air compressor.
5. Performance test on 4 – stroke single cylinder diesel engine.
6. Heat balance test on 4 – stroke single cylinder diesel engine.
7. Morse test on multi-cylinder petrol engine.
8. Retardation test on 4 – stroke single cylinder diesel engine.
9. Determination of COP of a refrigeration system.
10. Determination of COP of an air conditioning system.

Total : 45

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

CO1	Experiment and determine fuel and lubricant properties.
CO2	Draw the valve and port timing diagrams for the IC engines.
CO3	Experiment and analyze the characteristics and performance of IC engine and reciprocating air compressor.
CO4	Experiment and analyze the Heat balance test, Morse test and Retardation test in IC Engine.
CO5	Experiment and determine the COP of refrigeration and air conditioning systems.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3			3	3		2		3
CO 2	3	2	2	2		3			3	3		2		3
CO 3	3	2	2	2		3			3	3		2		3
CO 4	3	2	2	2		3			3	3		2		3
CO 5	3	2	2	2		3			3	3		2		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCT05 **APTITUDE AND LOGICAL REASONING** **L T P C**
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 and compute time, work, capacity and identify the pattern by analyzing the given problem/scenario
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 and Compute simple interest, compound interest for the given problem/scenario.
5. Use their logical thinking abilities to solve given problem involving direction sense, seating arrangement and coding & decoding.

UNIT 1 Unitary methods **6**

Number System, Time and Work, Pipes And Cisterns

UNIT 2 Numerical Computation **6**

Ratio and Proportion, Problems on Ages

UNIT 3 Numerical Estimation I **6**

Time and Distance, Problems on Trains, Boats and Streams

UNIT 4 Numerical Estimation II **6**

Percentage, Profit and Loss, Simple Interest and Compound Interest

UNIT 5 Logical Reasoning **6**

Direction Sense, Seating Arrangements, Coding and Decoding

TOTAL : 30 PERIODS

REFERENCES:

1 Dr.R.S.Aggarwal, “Quantitative Aptitude for Competitive Examination”, S.Chand Publications, 2022

2 Dr.R.S.Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S.Chand Publications, 2022

22MET51	MACHINE DESIGN	L	T	P	C
		3	1	0	4

Pre-requisites: Nil

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.

UNIT 1 STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9+3

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 9+3

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 9+3

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 9+3

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 9+3

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.

Lecture: 45, Tutorial : 15, Total : 60

DATA BOOKS:(allowed for reference during examinations also)

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.

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

CO1 Classify and explain the various steps involved in the design process, steady stresses and variable stresses in machine members.

CO2 Explain procedures involved in the design of shafts keys, splines and couplings.

CO3 Demonstrate the knowledge on the designs of threaded fasteners, Knuckle joints, Cotter joints, welded and riveted joints.

CO4 Design of flywheel, fasteners and different types spring for the specific applications.

CO5 Select appropriate rolling contact bearing, gasket and seal from the standard catalog based on loads.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3	2								2	2	
CO 2	3	2	3	2								2	2	
CO 3	3	2	3	2								2	2	
CO 4	3	2	3	2								2	3	
CO 5	3	2	3	2								2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET52	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites: Thermal Engineering

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.

UNIT 1 VEHICLE STRUCTURE, ENGINES AND SAFETY 9

Types of automobiles - Vehicle construction and different layouts - Chassis, frame and body. Vehicle aerodynamics (flow phenomenon – drag, side, lift and rolling resistance) - IC engines – Operation, Components and materials. Vehicle safety systems - Regulations and test standards. Trends in automobile design and vehicle maintenance.

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 - Typical performance, combustion and emission characteristics of automobile engines - 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. Pneumatic and hydraulic braking systems - Antilock Braking System (ABS) - Electronic brake force distribution (EBD) and Traction control - Electronic stability control. Suspension systems - types, factors influencing ride comfort and shock absorbers.

UNIT 5 AUTOMOTIVE ELECTRICAL AND ELECTRONICS 9

Automotive – lighting, sensors and actuators. Vehicle Management System- vehicle tracking system, Collision avoidance, Radar warning system, Global Positioning Systems (GPS).

Fundamentals of electric and hybrid vehicles - Layout and operation - Power electronics - Electric machines and drives - Power train - Regenerative braking – Energy Sources Battery-Lead acid battery, Li-ion Battery - Construction, Cell Discharge & Cell Charge Operation – Hydrogen fuel cell. Case study on IoT in automotive industry.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Kirpal Singh, “Automobile Engineering”, Vol.1&2, 14th Edition, Standard Publishers 2021.
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. Tom Denton, Automobile Electrical & Electronic Systems (5th Edition), Taylor and Francis, 2018.

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

CO1 Classify vehicle structure, components, materials and safety systems in the automobile.

CO2 Explain the function of fuel injectors systems and awareness of emissions through various norms.

CO3 Discuss about torque transmission to wheels through types of gear boxes and its associated components.

CO4 Differentiate steering gear boxes and to impart knowledge on latest developments in braking system and suspension system.

CO5 Analyze various electrical and electronics system for vehicle management.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3	2		2			2	3	
CO 2	3	3	3	2		2	3		2			3		3
CO 3	3	3	3	2		2	2		2			2	3	
CO 4	3	3	3	2	2	3	2		2			3	3	
CO 5	3	3	3	2	3	2	3		2			3	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET53	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	0	3

Pre-requisites: Basic knowledge in linear and angular measurement systems studied in Physics.

Preamble

Metrology and Measurements course enable the students to gain knowledge on basic concepts of metrology and various measurement systems like linear, angular, form, advancement and mechanical parameters and also obtain familiarity to choose appropriate metrological equipments and procedure to do measurements.

UNIT 1 BASICS OF MEASUREMENT **9**

Introduction to metrology – Need for measurement – Methods of measurement –Generalized measuring system. Units and standards - Fits and Tolerances - Factors affecting measurement - SWIPE -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, Vernier Height gauge, Slip gauges - Optical Flat. Comparators - Mechanical, Electrical and Pneumatic.

Angular measuring instruments – Sine bar and Sine Centre– 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 – Principle of interference – Laser interferometer – Types – Michelson interferometer – DC and AC interferometer - Applications.

Basic concept of Coordinate measuring machine (CMM) – Types – constructional features – Probes – Errrors and Calibration. Basic concept of Machine vision system – Element – Applications – Case study on Machine Vision.

UNIT 4 FORM MEASUREMENT **9**

Screw thread measurement – Terminology, Thread gauges – Floating carriage micrometer for external thread– Gear measurement – Types of gears – Gear terminology – Spur gear profile measurement by Profile projector– Parkinson gear tester.

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 and LVDT. 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 and Thermistors.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Thomas G.Beckwith, Roy D. Marangoni and John H.Lienhard V., "Mechanical Measurements", Pearson Education, 2020.
2. Jain R.K., "Engineering Metrology", Khanna Publishers, 2022.

REFERENCES:

1. Rajput.R.K., "A Textbook of Measurements & Metrology", Kataria & sons, 2013.
2. Raghavendra, Krishnamurthy., "Engineering Metrology and Measurements", OUP India, 2013.
3. National Physical Laboratory Guide No. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.

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

CO1 Describe the concepts of measurements to apply in the metrological instruments.
CO2 Outline the principle and applications of linear and angular measurement tools used for industrial applications.
CO3 Illustrate the applications of laser in measurement and the procedure for conducting computer aided inspection.
CO4 Apply the principles and methods of form and surface metrology.
CO5 Discuss the various mechanical parameter measuring instruments.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2	1								2	2	
CO 2	2	2	2	1						2		2	2	
CO 3	2	2	2	2						2		2	2	
CO 4	3	3	2	3						3		2	2	
CO 5	2	3	2	3								2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL51 COMPUTER AIDED DESIGN LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Computer Aided Drafting and Modelling Laboratory

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.

LIST OF EXERCISES

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. Conversion of 3D Solid Model to 2D Drawing – Different Views – Sections – Isometric View and Annotation Creation (Anyone from above exercise)
12. Manufacturing Prototype of a Simple Mechanical Component using 3D Printer.

Total : 45

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

CO1	Perform the part modelling and assembly drawing of couplings with the application of CAD software.
CO2	Prepare the part modelling and assembly drawing of Plummer block and screw jack with the application of CAD software.
CO3	Perform the part modelling and assembly drawing of universal and knuckle joints with the application of CAD software.
CO4	Perform the part modelling and assembly drawing of stuffing box and engine parts with the application of CAD software.
CO5	Apply the advanced feature creation concept of CAD for Modeling and Assembly.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3	3	2			3	3	1	3	3	
CO 2	3	3	3	3	3	2			3	3	1	3	3	
CO 3	3	3	3	3	3	2			3	3	1	3	3	
CO 4	3	3	3	3	3	2			3	3	1	3	3	
CO 5	3	3	3	3	3	2			3	3	1	3	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL52	DYNAMICS AND METROLOGY LABORATORY	L	T	P	C
		0	0	2	1

Pre-requisites: Dynamics of Machinery, Metrology and Measurements

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.

LIST OF EXERCISES

DYNAMICS LABORATORY

STUDY EXPERIMENTS

1. Determination of mass moment of inertia using bifilar suspension.
2. Balancing of reciprocating masses.

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. Balancing of rotating masses.

METROLOGY AND MEASUREMENT LABORATORY

STUDY EXPERIMENTS

1. Calibration of precision measuring instruments - Vernier Caliper, Micrometer and Vernier Height Gauge.
2. Inspection of specimens using mechanical and electrical Comparators.

LIST OF EXPERIMENTS

1. Measurement of taper angle using Sine Bar and Sine Center.
2. Measurement of angular dimension of the given work piece using Bevel Protractor and bore gauge.
3. 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.
4. 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

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

CO1 Estimate the gyroscopic couple and critical speeds of shafts using gyroscope and whirling of shafts apparatus.

CO2 Determine the natural frequency of vibration of beams, shafts and springs using cantilever beam, single rotor system and spring mass system.

CO3 Construct the characteristic curves for governors using universal governor apparatus and balance the unbalanced rotating masses using static and dynamic balancing apparatus.

CO4 Estimate gear tooth dimensions, angles and screw thread parameters using gear tooth vernier, Floating carriage micrometer, Profile projector and tool maker's microscope.

CO5 Measure temperature, force, torque and vibration using temperature and force measuring instruments, torsion bars and vibration setup.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2		3			3	3		2	3	
CO 2	3	3	3	2					3	3		2	3	
CO 3	3	3	3	2		3			3	3		2	3	
CO 4	3	3	3	2					3	3		2	3	
CO 5	3	3	3	2					3	3		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCL06	COMMUNICATION SKILLS LABORATORY (Fifth / Sixth Semester)	L	T	P	C
		0	0	2	0

Pre-requisites: Nil

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.

UNIT 1 RECEPTIVE SKILLS **6**

LISTENING & READING – Developing Listening & Reading Skills - Comprehension and Analysis – Listening & Reading for Main Idea - Specific Information - Cloze Test- Rearranging words and sentences

UNIT 2 PRODUCTIVE SKILLS **8**

SPEAKING & WRITING - Group Discussion and Practice – Mock GD - Structure – Types - Techniques - Keywords -Vital qualities - Attitude and Opinion - Expository and Persuasive Paragraphs – Picture Description

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

Orientation to International English Language Testing System (IELTS) and other Competitive Examinations – MCQs

UNIT 4 CAREER SKILLS **6**

Types of Interviews - FAQ's - Mock Interviews - Body Language - Team Work - Managing Time - Managing Stress - Negotiation Skills - Networking – Profile Creation (Linked in, Portfolio)

UNIT 5 VERBAL ABILITY **6**

Synonyms and Antonyms - Idioms and Phrases - Sentence Construction and Improvement- Paraphrasing - Contextual Vocabulary - Verbal Analogy

Total : 30

REFERENCES:

1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
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. https://www.teachingenglish.org.uk/article/email-writing
2. http://www.oxforddictionaries.com/words/writing-job-applications
3. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers
4. www.cambridgeenglish.org

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

CO1 Respond quickly and correctly to questions from different types of scripts, exhibiting good comprehension and analyzing skills

CO2 Participate effectively in formal group discussions and prepare professional e mails, persuasive and expository paragraphs to establish and meet organizational needs and goals.

CO3 Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time.

CO4 Write effective résumés, and face interviews with communicative competence and confidence, with a good knowledge of career skills .

CO5 Select appropriate vocabulary and idiomatic expressions, identify errors in syntax, and arrange sentences to make meaningful paragraphs, without any aid.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1					3					3				
CO 2									3	3				
CO 3										3		1		
CO 4									3	3		1		
CO 5										3		1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET61	DESIGN OF TRANSMISSION SYSTEMS	L	T	P	C
		2	1	0	3

Pre-requisites: Machine Design

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 gives a detailed view about the design of cams, clutches and brakes.

UNIT 1 DESIGN OF FLEXIBLE ELEMENTS 6+3

Motor power capacity for various applications -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 6+3

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 – -Module-normal and transverse, Force analysis – Stresses in helical gear – Design of helical gear.

UNIT 3 DESIGN OF NON-PARALLEL GEARS 6+3

Straight bevel gear: Gear Materials -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 6+3

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 AND CLUTCHES 6+3

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

Lecture: 30, Tutorial : 15, Total : 45

DATA BOOK: (Allowed for referencing during examination.)

1. PSG Design Data Handbook, Kalaikathir Achchagam,2023

TEXT BOOKS:

1. Shigley, J.E. and Mischke, C. R., “Mechanical Engineering Design”, 10th edition, McGraw-Hill Education, New York, 2017.
2. Bhandari, V.B., “Design of Machine Elements”, Fourth edition, McGraw Hill Education India Private Limited, New Delhi, 2017.

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", Sixth Edition, McGraw-Hill Education, New York, 2019.
3. Hamrock, B.J., Jacobson, B. and Schmid S.R., "Fundamentals of Machine Elements", Third edition, McGraw-Hill Education, New York, 2013.

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

CO1 Analyze different scenarios to determine the most suitable flat belts, V belts, hoisting wire ropes, and transmission chains based on specific requirements.

CO2 Evaluate the factor of safety in gear design and assess its adequacy for preventing failures under varying conditions.

CO3 Apply knowledge to estimate the dimensions of a pair of straight bevel gears based on given specifications.

CO4 Explain the nomenclature of various types of gears and gear boxes based on load and speed requirements.

CO5 Analyze and compute various design parameters of clutches, cams and brakes for a given application.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2			1					1	3	
CO 2	3	3	3	2								2	3	
CO 3	3	3	3			1						2	2	
CO 4	3	3	3									2	3	
CO 5	3	3	3									2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET62	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Pre-requisites: Basic knowledge on Thermodynamics

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.

UNIT 1 CONDUCTION **9+3**

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 **9+3**

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

UNIT 3 RADIATION **9+3**

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.

UNIT 4 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS **9+3**

Nusselt's theory of condensation- Regimes of Pool boiling and Flow boiling, correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors. LMTD and NTU methods.

UNIT 5 MASS TRANSFER **9+3**

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.

Lecture : 45, Tutorial : 15, Total : 60

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, 2013.
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, 2014.
2. Holman, J.P., "Heat and Mass Transfer", 9th Edition, McGraw Hill Education, 2010.
3. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", 4th Edition, New Age International, New Delhi, 2020.

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

CO1	Solve the one-dimensional conduction heat transfer under steady and unsteady states, subjected to appropriate boundary conditions.
CO2	Apply the physical concepts of convection heat transfer to analyze the problems related to various types of flows in different configurations.
CO3	Demonstrate about thermal radiation exchange between black and gray surfaces.
CO4	Outlining the facets of heat transfer for designing a heat exchanger.
CO5	Analyze the relation between heat and mass transfer.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2					2			1		3
CO 2	3	3	3	2					2			1		3
CO 3	3	3	3	2			2		2			1		2
CO 4	3	3	3	2			2		2			1		3
CO 5	3	3	3	2					2			1		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET63	FINITE ELEMENT ANALYSIS	L	T	P	C
		3	1	0	4

Pre-requisites: Strength of Materials, Machine Design

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.

UNIT 1 INTRODUCTION **9+3**

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 **9+3**

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 – Application to Field Problems – Solid Mechanics – Heat Transfer.

UNIT 3 TWO-DIMENSIONAL PROBLEMS **9+3**

Introduction – approximation of geometry and field variable – 3 noded triangular elements – four noded rectangular elements – 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

UNIT 4 ISOPARAMETRIC FORMULATION **9+3**

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.

UNIT 5 DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD **9+3**

.

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 (Qualitative Treatment only)

Lecture : 45, Tutorial : 15, Total : 60

TEXT BOOKS:

1. Ted Belytschko, “A First Course in Finite Elements”, John Wiley & Sons, Ltd,2007.
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2014

REFERENCES:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, McGraw-Hill Education, 2014
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

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

CO1 Identify and explain a mathematical model for solving engineering problems.
CO2 Analyze 1-D finite elements and build the stiffness matrix.
CO3 Solve the vector variable problems using two dimensional elements.
CO4 Solve the time-dependent and non-linear problems by applying discretization methods.
CO5 Explain the principles of finite element analysis in iso-parametric applications.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2	2							2	2	1
CO 2	3	3	3	3	2							2	3	2
CO 3	3	3	3	3	2							2	3	3
CO 4	3	3	3	3	3							2	3	
CO 5	3	3	3	2	2							3	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL61 DESIGN AND FABRICATION PROJECT

L	T	P	C
0	0	6	3

Pre-requisites: Knowledge of Mechanical Engineering and Software Packages.

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.

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 external examiners, internal examiners and guide constituted by the Head of the Department.

Total : 45

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

CO1 Select domain centric industrial or social problems.
CO2 Prepare detailed workflow chart.
CO3 Develop a conceptual and detailed design using modern engineering tools.
CO4 Fabricate new project models.
CO5 Perform test run and explore the findings in technical forum.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1			3	3	2	3	2	2	2	3	3
CO 2	3	3	3	2		3	3	2	3	3	2	2	3	3
CO 3	3	3	3	2	3	3	3	3	3	3	3	2	3	3
CO 4	3	3	2	2	3	3	3	3	3	3	3	2	3	3
CO 5	3	2			1	3	3	3	3	3	3	3	2	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL62 SIMULATION AND ANALYSIS LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Basic Knowledge on Finite Element Analysis

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.

LIST OF EXERCISES

List of Experiments

PART A. SIMULATION (Using software packages like MATLAB, SCILAB)

1. Simulation of Spring Mass Control System and Mass Control Damping System.
2. Simulation of Hydraulic / Pneumatic Cylinder.
3. Simulation of Cam and Follower Mechanism.

PART B. ANALYSIS

4. Force and Stress analysis using link elements in Trusses.
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. Conversion of 3D Model into Finite Element Model and to perform mesh.
12. Study of Multibody Dynamics (Automobiles)

Total : 45

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

CO1	Develop a program to simulate Cam follower mechanism, Hydraulic and Pneumatic system and Spring Mass control system using simulation software.
CO2	Analyze the force, stress, deflection in mechanical components.
CO3	Estimate the stress and deflection for Axi-symmetric component.
CO4	Analyze the modal frequency and harmonic concepts in cantilever, simply supported, fixed end beams using analysis software.
CO5	Estimate the thermal stress and heat transfer of plates using analysis software.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3	3	3			3	3		2	3	3
CO 2	3	3	3	3	3	3			3	3		2	3	
CO 3	3	3	3	3	3	3			3	3		2	3	
CO 4	3	3	3	3	3	3			3	3		2	3	
CO 5	3	3	3	3	3	3			3	3		2	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL63 HEAT AND MASS TRANSFER LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Engineering Thermodynamics

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.

LIST OF EXERCISES

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

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

CO1	Determine the thermal conductivity of lagged pipe, composite wall and insulating powder.
CO2	Analyse and interpret heat transfer parameters by conducting experiments on natural and forced convection apparatus.
CO3	Determine the effectiveness of parallel flow and counter flow heat exchangers.
CO4	Determine the emissivity of grey surface and Stefan Boltzmann Constant.
CO5	Analyse the performance of a fluidized bed cooling tower.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3			3	3		2		3
CO 2	3	3	2	2		3			3	3		2		3
CO 3	3	2	2	2	1	3			3	3		2		3
CO 4	3	2	2	2		3			3	3		2		3
CO 5	3	3	2	2	1	3			3	3		2		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET71	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Metrology and Measurements

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.

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, supplier rating and relationship development - Performance measures – Purpose – Methods.

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

The seven traditional tools of quality - New management tools - Business process reengineering - Six sigma: Concepts of six sigma, methodology - Applications to manufacturing and service sectors including IT.

Bench marking - Reason to benchmark, bench marking process - FMEA - Stages, types.

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

Control charts - Process capability - Acceptance sampling plans - 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 - IATF 16949 - TL 9000-IEC 17025 – ISO 2700 - TQM implementation in manufacturing and service sectors - Barriers in ISO implementation - OSHAS 18000 – Concept requirements and benefits – Case studies.

Lecture: 45, Total : 45

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.

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

CO1 Identify and explain the principles of quality management and dimensions of quality can be applied within quality management systems to attain customer satisfaction.

CO2 Appraise the organizational, communication and teamwork requirements for effective quality management

CO3 Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality.

CO4 Apply various statistical tools to measure quality and customer satisfaction.

CO5 Analyze the elements, documentation and environmental issues using quality systems to attain organizational standards.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		2					3			2	2		
CO 2	3		2					3	3	3	2	2		
CO 3	3	1	3	3				3			2	2		
CO 4	3	1	3	3				3			2	2		
CO 5	2	3	2	3		3	3	3			2	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET72	MECHATRONICS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

This course provides knowledge on system design, devices and products in achieving an optimal balance between basic mechanical structure and its control.

UNIT 1 FUNDAMENTALS OF MECHATRONICS SYSTEMS 9

Introduction - Key elements – Mechatronics design process –Types of Design: Traditional and Mechatronics design - Mechatronics in manufacturing systems - Adaptive and distributed control systems - Advanced approaches in Mechatronics - Industrial design and ergonomics, Safety.

UNIT 2 SENSORS AND ACTUATORS 9

Overview of sensors and transducers - Micro sensors Signal conditioning - Operational amplifiers - Protection Filtering - Analog and Digital converters.

Electro pneumatics and Electro hydraulics - Solenoids - Direct current motors – Servomotors - Stepper motors - Micro actuators; Drives selection and Application.

UNIT 3 MICROPROCESSOR BASED CONTROLLERS 9

Architecture of 8085 microprocessor and 8051 microcontroller. System interfacing for a sensor, keyboard, display and motors - Application cases for temperature control, warning and process control – Domestic Washing Machine.

UNIT 4 PROGRAMMABLE LOGIC CONTROLLERS AND SCADA 9

Architecture of programmable logic controllers – Input /Output modules – Programming methods – Timers and counters – Master control and jump controls – Branching – Shift Registers – Data handling – Analog input/output – Selection of PLC. SCADA - Definition – Elements of SCADA – SCADA control.

UNIT 5 INTELLIGENT MECHATRONICS AND CASE STUDIES 9

Fuzzy logic control and Artificial neural networks in mechatronics - Computer based instrumentation Real time data acquisition and control Software integration - Man Machine interface -Vision system - Types of vision system - Case studies on Mechatronics system – Car park barrier – Automatic camera - Electronics engine management system.

Lecture: 45, Total: 45

TEXT BOOKS:

1. Bolton W., "Mechatronics", 6th Edition, Pearson Education, New Delhi, 2019.
2. Nitaigour Mahalik, "Mechatronics", 3rd Edition, McGraw Hill Education, 2011.

REFERENCES:

1. Musa Jouaneh, "Fundamentals Of Mechatronics", Cengage Learning 2012.
2. Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics an Measurement systems", 4th Edition, McGraw Hill Education, 2014.
3. Bolton W., "Programmable Logic Controllers", Elsevier India (P) Ltd, New Delhi, 2011.

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

CO1 Identify the necessary components for mechatronics system design
CO2 Select suitable sensors, actuators and controllers to meet specific requirements.
CO3 Interpret the basic architecture and application of microprocessor 8085 and microcontroller 8051.
CO4 Describe the function and principles of operation of a programmable logic controller.
CO5 Build the mechatronics systems for real time applications.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1							3		2	3	3
CO 2	3	3	1									2	2	2
CO 3	3	2	3								2	2	3	3
CO 4	3	2	3									2	3	
CO 5	3	2	3								2	2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22HST71	HUMAN VALUES AND PROFESSIONAL ETHICS	L	T	P	C
		1	0	0	1

Pre-requisites: Universal Human Values

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.

UNIT 1 INTRODUCTION TO UNIVERSAL HUMAN VALUES 3

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 3

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 3

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 3

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 3

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.

Lecture: 15, Total : 15

TEXT BOOKS:

1. Gaur R R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics". 3rd Revised Edition, 2023
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.

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

CO1	Relate the significance of value inputs in a classroom and start applying them in their life and profession.
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.
CO3	Interpret the value of harmonious relationships based on the trust and respect in their life and profession.
CO4	Discuss the ethical issues related to Engineering.
CO5	Discuss Engineer’s work in the context of its impact on society.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1						2	3	2	2			2		
CO 2						3		3	1			2		
CO 3						2	2	3	3	3		2		
CO 4	1	2				3		2				2		
CO 5	2	2	1			3	2	2				2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL71 **AUTOMATION LABORATORY** **L T P C**
0 0 2 1

Pre-requisites: Mechatronics

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.

LIST OF EXERCISES

List of Experiments

1. Design and testing of 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

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

CO1	Model and analyze basic hydraulic, pneumatic and electrical circuits using automation software.
CO2	Design and test fluid power circuits using pneumatic, hydraulic, electro pneumatic, PID trainer kits and PLC controllers.
CO3	Develop and test assembly level programmes for 8085 microprocessor and test speed control of stepper motor using 8051 micro controller
CO4	Develop the manual CNC part programming using standard G and M codes in CNC machines.
CO5	Perform machining operations in CNC machine to produce required components.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3	3	1			3	3		2	3	3
CO 2	3	3	3	3	2	1			3	3		2	3	3
CO 3	3	3	2	3	3				3	3		2	3	
CO 4	3	3	2	3	3	3			3	3		2	3	
CO 5	3	2	2	3	3	3			3	3		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCT07 INDIAN CONSTITUTION AND TRADITIONAL KNOWLEDGE L T P C
3 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- Staterelationship, 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**

Panchayatraj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Blocklevel: 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, StateElection 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

TEXT BOOKS:TOTAL: 30 PERIODS

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

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

CO1	Describe the emergence and evolution of Indian Constitution, structure and composition of Indian Constitution and federalism in the Indian context.
CO2	List the functions of Centre, States and District Administrations, Fundamental rights needed to develop human personality in free society.
CO3	Identify different levels of Panchayat Raj system and its working.
CO4	Elaborate the role of Election Commission and its power to conduct free and fair election throughout India.
CO5	Develop a broad understanding of Indian society and intercultural literacy through cultural immersion.

CO – PO Mapping:

Course outcome	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1						3	2	2	2	2		2		
CO2						3	2	2	2	2		2		
CO3						3	2	2	2	2		2		
CO4						3	2	2	2	2		2		
CO5						3	2	2	2	2		2		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-" No correlation

22MEL81	INTERNSHIP	L	T	P	C
		0	0	4	2

Pre-requisites: Knowledge of Mechanical Engineering and Software Packages.

Preamble

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important, as employers are looking for employees who are properly skilled and have awareness about the industry environment, practices, and culture. The internship is structured, short-term, supervised training often focused on particular tasks or projects with defined time scales.

GUIDELINE FOR REVIEW AND EVALUATION

Students have to undergo four-week practical training in Mechanical Engineering related organizations of their choice but with the prior approval from the institution. At the end of the training student will submit a report as per the prescribed format to the department. The student shall make a power point presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made.

Evaluation of Project Report and Viva voce examination: 100 marks

(The student will be evaluated based on the report and the viva voce examination by an internal examiner)

Total: 30

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

CO1	Apply the acquired knowledge in the design of components and systems to solve the real-life problems.
CO2	Solve the given problems by applying the concepts of contemporary manufacturing systems.
CO3	Apply the principles of thermal and fluid sciences to solve the Engineering problems.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3	3	3	2	3	3	3	2	2	3	3
CO 2	3	3	3	3	3	3	2	3	3	3	2	2	3	3
CO 3	3	3	3	3	3	3	2	3	3	3	2	2	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEL82	PROJECT WORK	L	T	P	C
		0	0	20	10

Pre-requisites: Knowledge of Mechanical Engineering and Software Packages.

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.

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: 300

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

CO1 Discover potential research areas in the field of Mechanical Engineering.
CO2 Compare and contrast the several existing solutions for the problems identified.
CO3 Formulate and propose a plan for creating a solution for the research plan identified.
CO4 Conduct the experiments as a team and interpret the results.
CO5 Report and present the findings of the work conducted.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2	3	3	2	3	3	3	2	3	3	3
CO 2	3	3	2	2	2	3	3	3	3	3	2	3	3	3
CO 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO 4	3	3	2	2	3	3	3	3	3	3	2	3	3	3
CO 5	3	2	2	2	3	3	2	3	3	3	2	3	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE11	CAD / CAM / CIM	L	T	P	C
		3	0	0	3

Pre-requisites: Basic knowledge on Computer Aided Drafting and Manufacturing Processes.

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.

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 SHOP FLOOR DATA COLLECTION SYSTEMS 9

Introduction to Shop floor Data collection systems – Shop floor control – Shop floor data collection – Types of Data collection systems – Data Input Techniques – Automatic Data collection system – Bar Code Technology – Optical Character Recognition – Magnetic Ink Character Recognition – Voice Recognition Smart cards – Data Acquisition Systems (DAS).

Lecture: 45, Total : 45

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 Integrated Manufacturing”, 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.

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

CO1 Explain the implementation of a CAD system in a design process.
CO2 Apply the concept of parametric design in 2D Drafting.
CO3 Summarize the steps involved in Computer Aided Manufacturing and process planning.
CO4 Explicate the concepts of group technology and also the cellular manufacturing concepts.
CO5 Illustrate the concepts of shop floor data collection systems in the industrial sector.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2	2							2	2	
CO 2	3	2	2	2	2					3		1	3	
CO 3	3	2	2	2	2				1	2	2	2	2	
CO 4	3	2	2	2						2	2	2	2	
CO 5	3	2	2	2							1	2	2	

1 – Slight (Low), 2 – Moderate (Medium), 3 – Substantial (High).

22MEE12	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Pre-requisites: Materials Science, Engineering Materials and Metallurgy

Preamble

This course provides students with 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.

UNIT 1 FIBERS AND MATRIX MATERIALS 9

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

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 – -rule of mixtures-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 - Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint Ceramic Laminates, Hybrid Composites- carbon nano fibers – carbon nanotubes (CNTs) – production and properties of CNTs. Micromechanics of Composites - Fatigue and Creep - Designing with Composites.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Krishnan K Chawla, “Composite Materials: Science and Engineering, 4th Edition, Springer, 2019.
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", 2nd edition,CRC Press, 2006.
2. Hull D, Clyne TW., "Introduction To Composite Materials",2nd edition, Cambridge University Press – New Delhi, 1996, Online publication 2012.
3. Raonald F Gibson, "Principles of Composite Material Mechanics", CRC Press – London, 4th Edition,2016.

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

CO1	Identify and explain the types of matrix materials and reinforcements used in composite materials based on their applications.
CO2	Explain the processing methods of MMCs.
CO3	Classify ceramic matrix materials and develop the fabrication of CMC through pressing, infiltration, and chemical processing methods.
CO4	Choose polymers and fabrication techniques, and build polymer matrix composites.
CO5	Select the appropriate composite material based on the properties and advantages of advanced composite materials.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2				1					2	2	
CO 2	3	2	2	2								2	2	
CO 3	3	2	2	2								2	2	
CO 4	3	2	2	2								2	2	
CO 5	3	2	2				2					2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE13 DESIGN AND ANALYSIS OF EXPERIMENTS

L	T	P	C
3	0	0	3

Pre-requisites: Machine Design

Preamble

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

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.

Lecture : 45, Total : 45

TEXT BOOKS:

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

REFERENCES:

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

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

CO1	Select an appropriate design, conduct the experiment and interpret the result using appropriate statistical techniques.
CO2	Solve the problem by optimizing the product/process parameters.
CO3	Predict the outcomes through statistical concepts.
CO4	Demonstrate process/product optimization through statistical concepts.
CO5	Discuss the principles and methods of statistical analysis of experimental designs.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	3	1							2	3	
CO 2	3	2	2	3	1							2	3	
CO 3	3	2	2	3	1							2	3	
CO 4	3	2	2	3	1							2	3	
CO 5	3	2	2	3	1							2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE14 **MECHANICAL VIBRATIONS** **L T P C**
3 0 0 3

Pre-requisites: Dynamics of Machinery and Dynamics Laboratory

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.

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 under harmonic force – 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 planes.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Singiresu S Rao, Mechanical Vibrations, Pearson Education, 6th edition, 2018.
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, 2017.
3. Balakumar Balachandran, , Edward B Magrab, Fundamentals of Vibrations, Cengage Learning, 2009

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

CO1 Explain the fundamental concepts of vibration pertaining to single degree of freedom and solve the problems.

CO2 Solve simple problems in torsional vibration related to two degree of freedom for estimating the frequency of vibration.

CO3 Solve simple problems in vibration associated with multi degree of freedom for calculating the natural frequency of vibration.

CO4 Illustrate and analyze the vibration of continuous systems like shafts and beams.

CO5 Apply the vibration measurement and control techniques using specific devices like Transducer for the control of natural frequency of vibrations.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2								2	3	
CO 2	3	3	3	2								2	3	
CO 3	3	3	3	2								2	3	
CO 4	3	3	3	2								2	3	
CO 5	3	3	3	2								2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE15 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS

L	T	P	C
3	0	0	3

Pre-requisites: Knowledge in Manufacturing Technology, Engineering Materials and Machine Design.

Preamble

The course provides basic aspects in designing of jigs, fixtures, press tools and dies for holding cutting tool and workpiece during machining and metal forming processes within the specified tolerance for industrial applications.

UNIT 1 LOCATING AND CLAMPING DEVICES **9**

Introduction – Materials used in Jigs and Fixtures - 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 Pinion 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 – Lathe fixture – Broaching Fixture – Milling Fixture - Grinding Fixture – Inspection fixture – Welding fixture – Air operated Fixture – Modular Fixtures

UNIT 4 PRESS TOOLS **9**

Introduction – Press working terminology – Estimation of Press capacity – 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.

Lecture : 45, Total : 45

TEXT BOOKS:

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

REFERENCES:

1. Donaldson, George H. Lecain, Joyjeet Ghose and Goold V.C, “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
2. Ivana Suchy, “Handbook of Die Design”, McGraw Hill Book Co., 2006.
3. Joshi P.H, "Jigs & Fixtures", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2012.

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

CO1 Illustrate the principles of locating and clamping and analyze the related forces.
CO2 Explain the classification of jigs, identify and design suitable jigs for various elements.
CO3 Explain the classification of fixtures, identify and design suitable fixtures for various elements.
CO4 Illustrate the classification and function of presses and dies and also design them.
CO5 Discuss the various forming processes and computer aided design analysis principle for sheet metal dies.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3			2						2	3	
CO 2	3	2	3			2						2	3	
CO 3	3	2	3			2						2	3	
CO 4	3	2	3			3						2	3	
CO 5	3	2	3		2	3						2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE16	INDUSTRIAL TRIBOLOGY	L	T	P	C
		3	0	0	3

Pre-requisites: Fluid Mechanics and Machinery

Preamble

This course deals with the fundamentals of friction, wear, lubrication and design aspects of bearing.

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 nonmetals. 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 , Self-Lubricating materials – Introduction to Bio lubricants.

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 JOURNAL BEARINGS AND MATERIALS FOR BEARINGS **9**

Bearing Geometry – Pressure Distribution – Load Capacity Practical and Operational Aspects of Journal Bearings –Thermal Effects in Bearings. 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.

Lecture: 45, Total : 45

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.

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

CO1 Explain topography and friction mechanisms of metals and non metals using knowledge of surface roughness of materials for knowing the effect of friction.

CO2 Illustrate the wear of materials to choose materials for adhesive and abrasive wear situations with reference of nature of wear.

CO3 Classify the lubricants and types of lubrication for selecting a lubricant which meets the need of particular lubrication.

CO4 Describe fluid film prevailing in bearing surfaces in working condition for recognizing the type of lubrication.

CO5 Select appropriate materials for various types of bearings for expected functionality compliance with Tribology Handbook.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	2									1	3	
CO 2	3		2	1								2	3	
CO 3	3		2	1			2					2	3	3
CO 4	3	2	2							2		2	3	
CO 5	3	3	2	3								2	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE17	MACHINE DRAWING	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Graphics

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.

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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Basudeb Bhattacharya, - Text book of Machine Drawing, Oxford University press, New Delhi,2013
2. Goel B K, Goel P K, 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.

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

CO1 Discuss the concepts of machine drawing and codes of practice
CO2 Identify and explain the types of fits and tolerance.
CO3 Develop sectional views of fasteners, joints and couplings.
CO4 Develop assembly drawings of bearings and valves
CO5 Draw assembly of mechanical components and lathe machine parts.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2	1				2	2		2	2	
CO 2	3	3	3	2	1				2	2		2	2	
CO 3	3	3	3	2	2				3	3		2	3	
CO 4	3	3	3	2	2				3	3		2	3	
CO 5	3	3	3	2	2				3	3		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET21	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

Pre-requisites: Basic knowledge in CAD

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.

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 DESIGN FOR ADDITIVE MANUFACTURING **9**

Design tools: Data processing – CAD model preparation – Part orientation and support structure generation – Model slicing -Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities – DFAM for part quality improvement- Customised design and fabrication for medical applications.

UNIT 3 LIQUID BASED BASED ADDITIVE MANUFACTURING SYSTEMS AND DIRECTED ENERGY DEPOSITION **9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach – Advantages – Limitations – Applications. Digital Light Processing (DLP) -Process – Advantages – Applications. Continuous Liquid Interface Production (CLIP)Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process – Material Delivery -Materials -Benefits - Applications.

UNIT 4 SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **9**

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 5 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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2015.
2. D.T. P 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.

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

CO1 Describe the basics of additive manufacturing techniques.
CO2 Discuss the concepts of CAD modelling, data processing.
CO3 Apply the liquid and direct energy deposition additive manufacturing system for aerospace applications.
CO4 Explain the working principle of solid based additive manufacturing systems.
CO5 Analyze the characteristics of the powder based AM techniques in additive manufacturing.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2								2	2	3	
CO 2	3	3	3							1		2	3	
CO 3	3	2	2									2	3	
CO 4	3	1	2									2	3	
CO 5	3	3	3									2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE22	NON DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Materials and Metallurgy

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.

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. Principle of Magnetic particle Testing – Magnetic particle Testing 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 – Precautions against radiation hazards.

Lecture : 45, Total : 45

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.

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

CO1 Explain the visual inspection process using the equipment, procedure and light sources for visual inspection.

CO2 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.

CO3 Explain the thermography and eddy current testing process using the instrumentation and procedure for thermography and ECT.

CO4 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.

CO5 Explain the process of radiography testing using the equipment, types and procedure for radiography testing.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2			1					2	3	
CO 2	3	2	2	2		2	1					2	3	
CO 3	3	2	2	2			1					2	3	
CO 4	3	2	2	2			1					2	3	
CO 5	3	2	2	2		2	1					2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE23 UNCONVENTIONAL MACHINING PROCESSES

L	T	P	C
3	0	0	3

Pre-requisites: Basic Knowledge on Manufacturing Processes.

Preamble

Unconventional machining 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.

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, Material Removal Rate – Applications. Electrochemical machining – Principles of ECM – Equipment, Material Removal Rate, Electrical circuit, Process parameters, Electrostream drilling – Electrochemical grinding and Electrochemical honing, Electrochemical deburring – 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.

Lecture : 45, Total : 45

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.

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

CO1	Select appropriate advanced materials process for a given product or component recognizing material, size, precision, and surface quality requirements.
CO2	Demonstrate the working principles and equipment of ultrasonic machining and abrasive jet machining.
CO3	Outline the fundamentals of EDM and wire cut EDM processes.
CO4	Illustrate the concepts of electrochemical processes.
CO5	Discuss about thermal energy processes.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3		1							1	2	3	
CO 2	3	2	2									2	3	
CO 3	3	2	2									2	3	
CO 4	3		2									2	3	
CO 5	3		2									2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE24	DIGITAL MANUFACTURING AND IoT	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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

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

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

CO1 Impart knowledge to use various elements in the digital manufacturing.

CO2 Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.

CO3 Identify and select the proper procedure of validating practical work through digital validation in Factories.

CO4 Implement the concepts of IoT and its role in digital manufacturing.

CO5 Analyse and optimize various practical manufacturing process through digital twin.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		1		3	2	1	2		2		2	3	
CO 2	3	2	2	2	3	3	2	1	2	2		2	3	
CO 3	3	1	2	2	3	3	2	1	1	2		2	3	
CO 4	3	2	2	2	3	3	2	2	1	2		2	3	
CO 5	3	1	2	2	2	2	1	2	1	2		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE25	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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.

Lecture : 45, Total : 45

TEXT BOOKS:

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, 2017.

REFERENCES:

1. Mohammad Dastbaz , Peter Cochrane “Industry 4.0 and Engineering for a Sustainable Future” Springer, first edition, 2020
2. Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz “Industry 4.0: Industrial Revolution of the 21st Century” Springer,2019
3. Kaushik Kumar, Divya Zindani, J. Paulo Davim, “Digital Manufacturing and Assembly Systems in Industry 4.0”, CRC Press, 2019.

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

CO1 Discuss the principles of Industry 4.0 by using the concepts and characteristics of Industry 4.0.

CO2 Identify the drivers for developing the Industry 4.0 and impact of Industry 4.0 in various level of community.

CO3 Explain the basics and needs of Industrial Internet in an Industry based on principles and needs.

CO4 Describe the transformation of an Industry to Industry 4.0 by the customer experiences and feedback.

CO5 Apply the smartness based on I4.0 in smart factories, smart products and smart services.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		2								1	2	3	
CO 2	3					2		3			2	2	3	
CO 3	3								2		2	2	3	
CO 4	3	2	2			2			3	3	2	2	3	
CO 5	3		3		2							2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE26	FLEXIBLE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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, Material Requirement Planning. JIT, Lean and Agile manufacturing, Poka Yoke.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2006.
2. Mikell P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, 4th Edition, Pearson Education, US 2016.

REFERENCES:

1. Kalpakjin, “Manufacturing Engineering and Technology”, Addison- Wesley Publishing Co., 1995.
2. Radhakrishnan P, Subramanyan S, Raju V, "CAD/CAM/CIM", 4th Edition, New Age International Pvt. Ltd., 2018.
3. Joshi S B and Smith J S, "Computer Control of Flexible Manufacturing Systems", Springer, 2012.

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

CO1 Apply the concepts of PPC and GT to the development of FMS.
CO2 Discuss the planning and scheduling methods used in manufacturing systems.
CO3 Identify various workstations, system support equipments.
CO4 Identify hardware and software components of FMS.
CO5 Illustrate the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2		1								2	3	
CO 2	3	2	2	2	3					1		2	3	
CO 3	3	2	2	2	3					2		2	3	
CO 4	3	1	2	2	3					1		2	3	
CO 5	3	2	3	3	3	2	3			2		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE27 ADVANCED CASTING AND WELDING PROCESSES

L	T	P	C
3	0	0	3

Pre-requisites: Manufacturing Technology and Engineering Materials and Metallurgy

Preamble

This course enables the students to gain broad knowledge in advanced metal casting processes and its related technology, defects control, weldability and metallurgy of welding and also to select correct testing methods & quality aspects in welding

UNIT 1 METAL CASTING AND ADVANCED PROCESSES **9**

Casting processes: Classification, Metal mould casting processes- Advanced casting processes, Investment casting, Vacuum casting, Rheocasting - Mould and core making materials and their characteristics.

Technology of Selected casting Processes: Clay bonded, Synthetic resin bonded, Inorganic material bonded mould and Core making - Sand additives, Mould coating, Continuous casting process, Centrifugal casting process.

UNIT 2 DEFECTS IN CASTING AND CONTROL **9**

Casting defects - Process economics - Inspection, Diagnosis and Rectification - Mechanization and Automation in foundries - Use of robots - Casting design (Qualitative) - Pollution control - Energy and waste management in foundries.

UNIT 3 CHARACTERISTICS AND WELDABILITY IN ARC WELDING **9**

Physics of welding arc - Characteristics of arc - Modes of metal transfer - Welding fluxes - Electrode coating - Classification of electrode - Characteristics of welding power source - pulsed and inverter type power source, Power source for resistance welding.

Weldability - Weldability tests, Weldability of cast iron, Plain carbon steel- Determination of preheating temperature, Stainless steel- Use of Scheffler' s diagram.

UNIT 4 HEAT FLOW AND DISTORTION IN WELDING **9**

Heat flow in welding – significance - Theory of heat flow, Cooling rate determination (Qualitative) - Selection of welding parameters based on heat flow analysis - Residual stress and its measurement - Types and control of distortion.

UNIT 5 TESTING OF WELDED JOINTS **9**

Analysis of fatigue of welded joint - Fracture and toughness testing and its application on welded joint - Automated welded joint, Microprocessor based electrode movement controller in Resistance and Arc welding- Quality assurance in welding - Effects of welding fumes on environment.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Heine.R.W., Loper.C.R and Rosenthal.P.C, "Principles of Metal Casting", Tata McGraw Hill, 2017.
2. Parmar.R.S., "Welding Engineering and Technology" , 3rd edition, Khanna publishers, 2022.

REFERENCES:

1. Rao.P.N., "Manufacturing Technology", TMH, 4th edition,2017.
2. Seferian.D., "Metallurgy of Welding Technology", Chapman & Hall, 1985.
3. Jain.P.L., "Principles of Foundry Technology", Mc Graw Hill Education, 2017.

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

CO1 Classify various advanced metal casting process and technology behind them.
CO2 Identify defects and remedies in casting and explain automation in foundries.
CO3 Illustrate characteristics and weldability in arc of metals welding.
CO4 Demonstrate theory of heat flow and methods of distortion control in welding.
CO5 Explain various methods of testing joints and control in welding.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2									2	3	
CO 2	3	3	2									2	3	
CO 3	3	3	2							2		2	3	
CO 4	3	3	2									2	3	
CO 5	3	3	2									2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE31	LEAN MANUFACTURING AND SIX SIGMA	L	T	P	C
		3	0	0	3

Pre-requisites: Manufacturing Processes, Machining Processes, Flexible Manufacturing Systems

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.

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 – Why process management – Keys to process management - 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 – OEE calculation - 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 – APQP - PPAP

UNIT 4 SIX SIGMA 9

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation: DMAIC cycle – DMEDI – DMEDI Vs DMAIC - Quality function deployment or House of quality (QFD)– Failure mode and 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- Methods for assessing leanness - Project selection for lean systems.

Introduction to lean integrated with other systems: Lean six sigma – Lean and ERP – Leagile manufacturing – Lean enabled sustainability - Administrative lean.

Lecture : 45, Total : 45

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. Devadasan S.R, "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", Prentice Hall India Learning, 2012.
2. Niaz Ahmed Siddiqui, "Introduction to Six Sigma", New Age International Publishers, 2016.
3. N. Gopalakrishnan, "Simplified LeanManufacture: Element, Rules, Tools & Implementation", PHI, 2010.

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

CO1	Classify the wastes in production processes and explain the ways for waste elimination and value creation using the principles and rules of lean manufacturing.
CO2	Apply the appropriate lean primary tools for a particular situation based on the concepts of primary tools of lean manufacturing.
CO3	Classify the lean secondary tools and establish a continuous flow pull manufacturing environment using line balancing, JIT and Kanban.
CO4	Explain the six sigma implementation process using DMAIC methodology.
CO5	Describe the synergy effect of lean with other paradigms based on the principles of lean six sigma, lean enabled sustainability and leagile manufacturing.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3							3	1	3	
CO 2	3	3	3	3					3	3	1	2	3	
CO 3	3	3	3	2	3				2	2	1	2	3	
CO 4	3	3	3	3		2			2	2	1	2	3	
CO 5	3	2		2			2				3	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE32	PLANT LAYOUT AND MATERIAL HANDLING	L	T	P	C
		3	0	0	3

Pre-requisites: Manufacturing Processes, Machining Processes, Flexible Manufacturing Systems

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, equipment 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.

UNIT 1 SELECTION OF PLANT LOCATION AND WORKING CONDITIONS 9

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 AND DESIGN 9

Safe layout, equipment layout - Layout design procedures - 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, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, comparison of product and process layout - Code Compliance, OSHA, ADA regulations in facility design – Algorithms for plant layout design.

UNIT 3 MANUAL MATERIAL HANDLING 9

Material Handling principles - Preventing common injuries - Lifting by hand - Team lifting and carrying - Handling specific shape machines and other heavy objects – Accessories for manual handling - Problems with hazardous materials, liquids, solids – Storage and handling of cryogenic liquids- 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 - Relationship of material handling to plant layout.

UNIT 4 LIFTING TACKLES 9

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

Classification of material handling equipment - Selection of material handling equipment - Guidelines for effective utilization of material handling equipment - 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, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks –Maintenance of material handling equipment.

Lecture : 45, Total : 45

TEXT BOOKS:

1. James M.Apple., "Plant layout and material handling", 3rd edition, Krieger Publication, Malabar1991.
2. Agarwal.G.K., "Plant layout & material handling", Jain Brothers, 2019.

REFERENCES:

1. R.B. Choudhary and G.R.N. Tagore,"Plant Layout and Materials Handling", Khanna publishers 2nd Edition, 2001.
2. Siddhartha Ray., "Introduction to material handling", New Age International (P) Ltd, 2017.
3. Dr.Arora.K.C, Vikas V Shinde., "Aspects of material handling", Laxmi Publications, 2015.

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

CO1	List and classify various factors for selection of location and working conditions for a plant.
CO2	Model safe layouts for various types of plants using related software.
CO3	Illustrate the different types of manual material handling methods, equipment and functions.
CO4	Discuss the lifting tackles for material handling in mechanical based industries.
CO5	Explain the different types of mechanical material handling equipment, their functions and their maintenance techniques.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	2			1	1					1	3	
CO 2	3	3	3		3	3	1			3		1	3	
CO 3	3	2	2			3						1	3	
CO 4	3	2	2			3						1	3	
CO 5	3	2	2	1		3						1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE33	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

Pre-requisites: Manufacturing Processes

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.

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- Economics of process planning- case studies.

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 Milling, Shaping, Planning - Illustrative examples.

Lecture : 45, Total : 45

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.

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

CO1 Apply the knowledge on the work study and ergonomics concepts to implement in the workplace and design of tools and equipment.
CO2 Explain the scope and activities of process planning.
CO3 Classify the types of cost in the development of product.
CO4 Estimate the costs of forging, welding and casting process to make or buy the product.
CO5 Estimate the machining time required for lathe operations, shaping, planning and slotting operations for the manufacture of component.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2	2							2	1	3	
CO 2	2	2	2	2						2	2	1	3	
CO 3	3	3		3							3	1	3	
CO 4	3	3		3							3	1	3	
CO 5	3	3		3							3	1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE34	SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

UNIT 1 EVOLUTION AND SUPPLY CHAIN PERFORMANCE 9

Supply Chain – Historical perspective – Value Chain Perspectives - 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. The Impact of Uncertainty on Network Design. Case Studies

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 Multi echelon cycle inventory – role of safety inventory in a supply chain - The role of Radio-Frequency Identification in supply chain management. Case Studies

UNIT 4 DESIGNING AND PLANNING TRANSPORTATION NETWORKS 9

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. Designing a Sourcing Portfolio: Tailored Sourcing - Risk Management in Sourcing.

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 - The Role of Sustainability in Supply Chain **-** Future of IT in Supply Chain.

Lecture : 45, Total : 45

TEXT BOOKS:

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

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

CO1 Describe the importance of supply chain management.
CO2 Apply the forecasting techniques to improve the facility and network design.
CO3 Classify the techniques of inventory management.
CO4 Describe the design and planning methods in transportation networks.
CO5 Discuss the importance of supply chain in information technology field.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2								2		2	2	3	
CO 2	3	3		2					3		2	2	3	
CO 3	2	2		2					3		2	2	3	
CO 4	2	3	3	2	1	3			2		2	2	3	
CO 5	2				2		3		2		2	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE35	INDUSTRIAL SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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 WORKSHOP PROCESS SAFETY **9**

Workshop Safety Hand tools and Power tools - Safety while using Grinding stone - Welding and gas cutting safety – Identification of Dangerous points - Lubrication Safety-Safety in Cold Forming and Hot Working of Metals

UNIT 5 SAFETY INSPECTION AND AUDIT **9**

Safety Inspections -Safety Audit- Safety Survey - Plant safety inspection - Safety tour - Safety samplings - What is safety budget – Direct cost – indirect cost- Safety Equipment's & their budget preparation

Lecture : 45, Total : 45

TEXT BOOKS:

1. C. Ray Asfahl and David W.Rieske, "Industrial safety and Health Management", Prentice Hall Inc., NewYork, 2010.
2. Elahi Naseer," Industrial Safety Management, Kalpaz Publication, 2006.

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.

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

CO1 Explain the functions and activities of safety engineering department.
CO2 Carry out accident investigation, analysis and reporting.
CO3 Illustrate the use of critical thinking to identify and assess hazards in industries.
CO4 Discuss the various safety rules to be followed in workshop process.
CO5 Explain about safety inspection, conduct of safety audit and safety budget preparation.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		1	1		3			3		2	1	2	
CO 2	2	3	1	1		3				3	2	1	2	
CO 3	2	2	1	1		3	2		3		2	1	2	
CO 4	2		1			3						1	2	
CO 5	2		1			3						1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE36	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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. Game Theory Two Person Zero-Sum Games – Basic Terms– Maximin – Minimax Principle.

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).

Lecture: 45, Total : 45

TEXT BOOKS:

1. Gupta and Hira, “Problems in Operations Research”, S Chand and Company, New Delhi, 2014.
2. Hamdy ATaha, “Operations Research an Introduction”, 9th Edition, PHI/Pearson Education, 2019.

REFERENCES:

1. J.K.Sharma, “Operations Research: Theory and Applications” 5th Edition, Laxmi Publications, New Delhi, 2014.
2. Dharani Venkatakrishnan.S, “Operations Research”, Keerthi Publication House, Coimbatore, 2019.
3. R.Pannerselvam, “Operations Research”, 2nd Edition, PHI, 2015.

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

CO1	Formulate Engineering and business problems as LP problems and solve using simplex, Big M and Two Phase methods.
CO2	Solve transportation and assignment problems using MODI method and Hungarian algorithm.
CO3	Perform network analysis using PERT and CPM techniques.
CO4	Model queuing problems as Poisson arrival and exponential service models and calculate the queue length and waiting time.
CO5	Explain nontraditional optimization techniques using the concepts of Genetic algorithm and Ant colony optimization.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3		3	1					3	3	2	3	
CO 2	3	3		3	2						3	2	3	
CO 3	3	3		3	1				3	3	3	2	3	
CO 4	3	3		3							3	2	3	
CO 5	2	3	2	3	1						3	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE37 QUALITY CONTROL AND RELIABILITY ENGINEERING

L	T	P	C
3	0	0	3

Pre-requisites: Metrology and Measurements

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.

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 - – Gantt Chart -Process capability - Process capability studies and simple problems.

UNIT 2 PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –Control chart for non-conforming – 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 RELIABILITY CONCEPT, LIFE DATA ANALYSIS AND RELIABILITY ESTIMATION 9

Reliability definition –Reliability parameters- – Component mortality - Useful life.

Data classification – Non parametric methods: Ungrouped, Grouped, Complete, Censored data – Time to failure distributions - Survival graphs – Probability plotting: Exponential, Weibull - Goodness of fit tests – -Bartlett's test, KS test, chi-square test.

Series parallel configurations – Parallel redundancy – m/n system – Complex systems: RBD approach – Baye's method – Minimal path and cut sets - Fault Tree analysis – Standby system.

UNIT 5 RELIABILITY MANAGEMENT AND RELIABILITY IMPROVEMENT 9

Reliability testing: Failure terminated test – Time terminated test – Upper and lower MTBFs – Sequential Testing – Reliability growth monitoring – Reliability allocation.

Analysis of downtime – Repair time distribution – Maintainability prediction – Measures of maintainability – Availability definitions – System Availability – Replacement decisions – Economic life.

Lecture : 45, Total : 45

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

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

CO1 Summarize the concept of quality and process control for variables.
CO2 Determine the state of process control using control charts.
CO3 Classify the types of acceptance sampling.
CO4 Estimate the reliability of systems with series, parallel and mixed configurations.
CO5 Analyze the reliability of systems using various tests and identify the ways to improve system reliability.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	1	3						3		2	3	
CO 2	3	3	3	3						3		2	3	
CO 3	3	3	3	3								2	3	
CO 4	3	3	3	3								2	3	
CO 5	3	3	3	3							1	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE41	MAINTENANCE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites:

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.

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 - Failure modes -Bath Tub Curve- 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 – Overall Equipment Effectiveness.

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- Wear-debris analysis.

UNIT 4 REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9

Repair methods for beds, slide ways, spindles, gears and bearings – Failure analysis – Fault tree analysis, Event tree analysis, Failure Mode Effect 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 – Case studies.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Srivastava S.K., “Maintenance Engineering”, - 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., Revised Edition, 2012.
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.

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

CO1 Discuss the maintenance activities in industry and build successful management for maintenance activities.

CO2 Explain the maintenance strategies and the process of achieving them in various industry sectors.

CO3 Describe the condition monitoring methods and instruments for monitoring vibration, temperature, lubrication, corrosion and leakage.

CO4 Identify and explain the repair methods for lathe beds, slideways, spindles, gears and bearings.

CO5 Identify and explain the repair methods for material handling equipment like conveyors, elevators, fork truck and cranes.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	1							2	2	3	
CO 2	3	3	3	2		2			2			2	3	
CO 3	3	3	3	3	1	2			3			2	3	
CO 4	3	3	3	3	1	2	1		3	2	2	2	3	
CO 5	3	3	3	2		2			2	2	2	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE42	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Basic Knowledge on New Product Development.

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.

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. PLM characteristics – singularity, cohesion, traceability, reflectiveness, Information Mirroring Model

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, organization, 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.

Integration of Environmental Aspects in Product Design – Sustainable Development, Design for X System and tools, Design for Disassembly, Design for Environment, Need for Life Cycle Environmental Strategies

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.

Lecture : 45, Total : 45

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.

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

CO1 Explain history, concepts and terminology of PLM.
CO2 Apply the functions and features of PLM/PDM.
CO3 Summarize different modules offered in commercial PLM/PDM tools.
CO4 Illustrate PLM/PDM implementation approaches and integration of environmental aspects in product design.
CO5 Integrate PLM/PDM with other applications.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3										1	2	3	
CO 2	3		2								2	2	3	
CO 3	3	2	2		3	2					2	2	3	
CO 4	3	1	3				2				1	2	3	
CO 5	3	2	3	3		3	2				2	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE43	PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

UNIT 1 INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - Types of managers - Managerial roles and skills – concept of scientific management - Evolution of classical, behavioral and contemporary management thoughts – Types of business organization - Sole proprietorship, partnership-Kinds of partners, Company-public and private sector enterprises –Organization culture- 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, Career 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.

Lecture : 45, Total : 45

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.

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

CO1 Describe the principles of management and administration.
CO2 Explain the concepts of planning, organizing and controlling for managerial actions.
CO3 Identify and explain the management principles into practices.
CO4 Discuss the various functions of management to improve productivity.
CO5 Demonstrate knowledge on international aspect of management.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2					3		3	3	3	2	2	3	
CO 2	2		2					2	3	3	2	2	3	
CO 3	2		2			2		2	3	3	2	2	3	
CO 4	2					2		2	3	3	2	2	3	
CO 5	2		2					2	3	3	2	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE44 ENGINEERING ECONOMICS AND PROJECT MANAGEMENT

L	T	P	C
3	0	0	3

Pre-requisites: Nil

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.

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, Advantages and application areas. Make or buy decision- Criteria for Make or buy decision - Approaches for Make or Buy Decision.

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.

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).

Lecture: 45, Total: 45

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.

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

CO1	Apply knowledge of mathematics, economics, and engineering principles to solve engineering problems.
CO2	Determine the ability to account for time value of money using engineering economy factors and formulas
CO3	Explain the major capabilities and limitations of cash flow analysis for evaluating proposed capital investments
CO4	Analyze the replacement of an asset with a new asset using individual or group replacement methods.
CO5	Identify the depreciation and suggest suitable alternatives using depreciation methods.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3						3			2	2	3	
CO 2	3	3						3			3	2	3	
CO 3	2	3		3				2			3	2	2	
CO 4	3	3		3				3			3	2	3	
CO 5	3	3		2				3		3	3	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE45	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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- Smart manufacturing, Smart objects, patent, Intellectual property rights and copy rights.

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.)

Lecture : 45, Total : 45

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

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

CO1	Discuss fundamental concepts and customer specific requirements of the New Product development
CO2	Discuss the Material specification standards, analysis and fabrication, manufacturing process.
CO3	Develop Feasibility Studies & reporting of New Product development
CO4	Analyzing the New product qualification and Market Survey on similar products of new product development
CO5	Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3	2		2	1	2	2	2	2	2	3	
CO 2	3	2	3	2	2	2	1	2	2	2	2	2	3	
CO 3	3	2	3	2	2	2	1	2	3	3	2	2	3	
CO 4	3	2	3	2		2	1	2	3	3		2	3	
CO 5	3	2	3	2	2	2	1	2	2	2	2	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE46	ERGONOMICS IN DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites: Manufacturing Technology and Machine Design.

Preamble

This course enables the students to learn basic concepts in ergonomics and apply human factors, display and aesthetic aspects in the design approach to have safe working environment.

UNIT 1 INTRODUCTION TO ERGONOMICS **9**

Introduction to Ergonomics- Human Factors - overview and background - Communication system- General approach to the man-machine relationship- Capabilities and limitations of people -Human component of work system, Machine component of work system - Local environment-light, heat and sound.

UNIT 2 ERGONOMICS AND PRODUCTION **9**

Introduction- Human Body - Structure and Function - Anthropometric data and its applications in ergonomic- Working postures, Body Movements, Workstation 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 - Munsell 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 softwares, Total layout design. Scope of Ergonomics in India.

Lecture : 45, Total :45

TEXT BOOKS:

1. Marcelo M. Soares, Francisco Rebelo., Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics), CRC Press, 2019.
2. Ergonomics in Product Design by SendPoints Publishing Co. Ltd, 2018.

REFERENCES:

1. Bridger.R.S., "Introduction to Human Factors and Ergonomics", CRC Press, 2017.
2. Jan Dul, Bernard Weerdmeester., "Ergonomics for Beginners: A Quick Reference Guide", 3rd Edition, CRC Press, 2017.
3. Galer.I.A.R., "Applied Ergonomics Hand Book", Butterworth & Co, 1987.

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

CO1 Explain basics of ergonomics and human factors.
CO2 Interpret correct working postures related to work in ergonomic point of view.
CO3 Identify and explain design principles of display and control elements in working areas.
CO4 Outline environmental factors in ergonomics design.
CO5 Apply the aesthetic principles in working environment and product.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3	1		3			2	2		2	3	
CO 2	3	2	3	2		3			2			2	3	
CO 3	3	2	3	2		3			2			2	3	
CO 4	3	2	3	2		3			2			2	3	
CO 5	3	2	3	2		3			2			2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE47	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

Pre-requisites: Manufacturing Processes

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.

UNIT 1 INTRODUCTION **9**

Definition – Objectives of production Planning and Control – Functions of production planning and control – Elements of production control – Types of production – Organization of production planning and control department – Internal organization of department.

UNIT 2 FORECASTING **9**

Importance of forecasting – Types of forecasting, their uses – General principles of forecasting – Forecasting techniques – qualitative methods and quantitive methods.

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.

Lecture : 45, Total :45

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.

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

CO1 Understand the various components and functions of production planning and control.

CO2 Identify the basic procedure and selection of workstudy.

CO3 Able to prepare production planning and control activities such as work study, product planning, production scheduling, Inventory Control.

CO4 Understand the various steps in process planning and production planning.

CO5 Able to plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3					2				1	2	3	
CO 2	3	2		3							1	2	3	
CO 3	3	2									1	2	3	
CO 4	3	2	2						3	3	1	2	3	
CO 5	3	3	2		2						1	2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE51	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

Pre-requisites: Basic Knowledge on Thermodynamics and Fluid Mechanics.

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.

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 – Use of Gas tables

UNIT 5 PROPULSION **9**

Aircraft propulsion – Types of jet engines – energy flow through jet engines, -Performance calculation of turbo jet engines –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.

Lecture : 45, Total : 45

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 Education, 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.

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

CO1	Distinguish between the compressible and incompressible states of fluid.
CO2	Perform one dimensional isentropic analysis of the fluid flow changes in design parameters of nozzles and diffusers.
CO3	Interpret the effects of friction and heat transfer on compressibility of the flowing fluid.
CO4	Identify and explain the abnormalities in a fluid flow due to shock in a real system.
CO5	Explain the fundamentals of jet propulsion, propulsion cycle and rocket propulsion.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	2		2						2		3
CO 2	3	3	3	2		2						2		3
CO 3	3	3	3	2		2						2		3
CO 4	3	3	3	2		2						2		3
CO 5	3	3	3	2		2						2		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE52	POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites: Basic Knowledge on conventional and non-conventional energy sources.

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.

UNIT 1 STEAM POWER PLANT AND BOILERS **9**

Steam power plant layout – working – Auxiliaries – Steam power cycle- improvement and limitations - Fuel and ash handling – combined cycle power generation.
Classification of Boilers – Lamont, Benson, Loeffler, Velox -Efficiency calculation.

UNIT 2 NUCLEAR POWER PLANTS **9**

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

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 POWER FROM RENEWBALE ENERGY **9**

Hydro Electric Power Plants — Classification, Typical Layout and associated components including Turbines. Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geothermal, Biogas and Fuel Cell power systems.

UNIT 5 ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES 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.
Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

Lecture : 45, Total : 45

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, 2008.

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. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.

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

CO1 Describe the construction and working principle of steam power plant and boilers.
CO2 Explain the layout, construction and working of the components of nuclear power plants.
CO3 Discuss the components and working principles of diesel and gas turbine power plants.
CO4 Explain the various types of renewable energy sources and its working principles.
CO5 Explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards and estimate the costs of electrical energy production.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	1		2	2			2		2		2
CO 2	3	2	2	1		2	2			2		2		2
CO 3	3	2	2	1		2	2			2		2		2
CO 4	3	2	2	1		2	2			2		2		2
CO 5	3	2	2	1		2	2			2	3	2		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE53	ADVANCED I.C. ENGINES	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Thermodynamics, Automobile Engineering

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.

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 – Spark Knock - Factors affecting knock– Combustion chambers.

UNIT 2 COMPRESSION IGNITION ENGINES

Diesel fuel injection systems - Stages of combustion – Knocking – Factors affecting knock – Direct and indirect injection systems – Common Rail Direct 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 - In-cylinder treatments - Three-way Catalytic Converter, Selective Catalytic Reduction, De-NOx Catalyst, 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 - Alternative fuels for IC engines – Hybrid vehicle, Fuel Cell.

Lecture: 45, Total : 45

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 2013.

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.

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

CO1 Explain the types of fuel injection system and combustion process of spark ignition engines.

CO2 Illustrate the combustion process and fuel spray characteristics inside the cylinder of compression ignition engines.

CO3 Identify the cause of the pollutant formation and emission control techniques to control pollutants in spark ignition and compression ignition engines.

CO4 Describe the operation and use of air flow, pressure, temperature, speed, exhaust gas oxygen, knock and position sensor of engine management system in an automobile.

CO5 Compare the advantages and limitations of the recently developed IC engines over the conventional IC engines.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2	2	2	2		2			2		3
CO 2	3	2	2	2	2	2	2		2			2		3
CO 3	3	2	2	2	3	3	3		2			2		3
CO 4	3	2	2	2	3	2	2		2			2		3
CO 5	3	2	2	2	3	2	3		2			2		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE54	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Thermodynamics and Thermal Engineering

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.

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 and Commercial 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 – Multiple evaporator and compressor system.

UNIT 3 OTHER REFRIGERATION SYSTEMS AND SAFETY IN RAC 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. Installation, commissioning, noise, vibration, electrical connections and safety in RAC 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, DUCT DESIGN 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.

Fundamentals of duct design and pressure loss. Introduction to HVAC Systems – Fundamentals, Scope of HVAC, Mode of Heat Transfer and Standards.

Lecture: 45, Total : 45

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 4th edition, McGraw Hill, New Delhi, 2021.
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", 2nd edition McGraw Hill, New Delhi, 2014.
2. Manohar Prasad, “Refrigeration and Air conditioning”, 3rd edition, New Age International (P) Ltd, NewDelhi, 2021.
3. ASHRAE Handbook - HVAC Applications, 2023.

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

CO1	Explain the refrigeration cycles and select environmentally benign refrigerants based on refrigerant properties.
CO2	Determine the COP of vapour compression refrigeration cycle with p-h and T-s diagrams.
CO3	Discuss the types of refrigeration systems and adopt suitable safety in RAC systems.
CO4	Describe the air conditioning processes using principles of Psychrometry and requirements of comfort air conditioning.
CO5	Estimate cooling/heating loads in an air conditioning system and impart knowledge on duct design and HVAC.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2	2	3	2		2			2		3
CO 2	3	2	2	2		3	2		2			2		3
CO 3	3	2	2	2	1	2	2		2	2		2		2
CO 4	3	2	2	2	1	2	2		2			2		2
CO 5	3	2	2	2	1	3	2		2			2		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE55	FLUID POWER SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisites: Fluid Mechanics and Machinery

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.

UNIT 1 FLUID POWER SYSTEMS AND FUNDAMENTALS 9

Introduction to fluid power - Advantages of fluid power - Applications of fluid power system - and limitations-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, Rod less, 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.

Lecture : 45, Total : 45

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, 1st edition Reprint 2017.

REFERENCES:

1. Jagadeesha T , “Hydraulics and Pneumatics”, I K International Publishing House,2015.
2. Andrew Parr, “Hydraulics and Pneumatics”, Butterworth Heinmann, 2006.
3. Srinivasan.R, “Hydraulic and Pneumatic controls”, Vijay Nicole, Second edition 2008.

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

CO1 Apply fluid power principles to solve practical problems and Demonstrate the use of fluid power symbols in system design.

CO2 Analyze the construction details to understand the strengths and weaknesses of gear pumps, vane pumps, and piston pumps.

CO3 Analyze the suitability of 3/2,4/2 way valves, Shuttle valve, Check valve, Pressure control valve – Sequence valve, Flow control valve – Fixed and adjustable, electrical control solenoid valves for different hydraulic systems.

CO4 Evaluate the components and operation of a pneumo hydraulic circuit in a given system.

CO5 Evaluate the performance and efficiency of electro-hydraulic servo systems in various applications, Examine the design and functionality of fluidic devices in different circuits and Analyze the logic and functionality of electro-hydraulic pneumatic logic circuits.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2				1			2		2	2	2
CO 2	3	2	3									2	2	2
CO 3	3	2	3		2					3		2	3	3
CO 4	3	2	3		2					2		2	2	2
CO 5	3	2	3		2					2		2	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE56 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

Pre-requisites: Fluid Mechanics and Machinery, Finite Element Analysis

Preamble

Computational fluid dynamics are of great practical importance in many branches of science and engineering. Fluid dynamics addresses introducing 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.

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. Application to simple control volumes.

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 –Problems on elliptic and parabolic equations.

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 - 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 – Industrial Case studies

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 – Introduction to flow analysis software - Applications of CFD.

Lecture : 45, Total : 45

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.

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

CO1 Explain the fundamentals of governing equations of viscous fluid flow.
CO2 Apply the knowledge on finite difference method for fluid flow calculations.
CO3 Discuss the concepts of finite volume method (FVM) for diffusion.
CO4 Identify and explain the significance of finite volume method for convection diffusion.
CO5 Apply the concepts of FVM for fluid flow calculations.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2					2			2		2
CO 2	3	3	2	2					2			2		2
CO 3	3	3	2	2					2			2		3
CO 4	3	3	2	2					2			2		3
CO 5	3	3	2	2	3				2			3		3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE57	CRYOGENIC ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Thermodynamics, Fluid Mechanics and Heat Transfer

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.

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.

Low Temperature Properties - Properties of Engineering Materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenic fluids.

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 – Magnetic 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 AND CRYOGENIC INSTRUMENTATION 9

Cryogenic Dewar - Cryogenic Transfer Lines - Insulations used in Cryogenic Systems and insulating methods – Instrumentation to measure flow-rate, pressure, liquid-level and temperature. Cryo Pumping Applications.

Lecture: 45, Total :45

TEXT BOOKS:

1. Thomas M.Flynn, “Cryogenic Engineering”, 2nd edition, CRC Press, 2020.
2. Mamata Mukhopadhyay, “Fundamentals of Cryogenic Engineering”, PHI Learning Private Limited, 2013.

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.

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

CO1	Identify and explain the cryogenic systems and evolution of low temperature science.
CO2	Illustrate the components of liquefaction systems.
CO3	Apply the knowledge on gas separation and purification systems.
CO4	Analyse the common cryogenic refrigeration systems, fluid storage and transfer systems.
CO5	Explain the transfer lines and instrument used in cryogenic systems and to understand cryo pumping

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	2			2	2					2		2
CO 2	2	2	2			2	2					2		2
CO 3	3	2	2			3	2					2		3
CO 4	2	2	2			2	2					2		2
CO 5	2	2	2	2		2	2					2		2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE61	ENTERPRISE RESOURCE PLANNING (ERP)	L	T	P	C
		3	0	0	3

Pre-requisites: Introduction to Management Information Systems

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.

UNIT 1 ENTERPRISE RESOURCE PLANNING AND VALUE CHAIN MANAGEMENT **9**

Principle –ERP framework –Business Blueprint –Business Engineering vs Business process Re-Engineering –Tools –Languages –Value chain –Supply and Demand chain –Extended supply chain management –Dynamic Models –Process Models–MRP - Material Requirement Planning,
BOM - Bill Of Material – Benefits of ERP.

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 –Comparison of Big Bang vs. Phased Approach, Implementation Strategy in Small and Medium Enterprise – 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.

Lecture : 45, Total : 45

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.

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

CO1	Able to acquire integrated view of the various facets of business, including planning, manufacturing, sales, finance and marketing.
CO2	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.
CO3	Awareness on the software applications and tools that are available to business to use to drive out costs and improve efficiency.
CO4	Understand the architecture of various ERP packages available in the market.
CO5	Ability to learn the outsourcing concepts of ERP and its economics.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3										2	
CO 2	3	1	3										2	
CO 3	3	3	3	2	2	2						2	2	
CO 4	3	2	3	2	2						1	2	2	
CO 5	3	2	3	3	1						2	2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE62	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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 - Global issues - Regional and local issues - 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

Lecture : 45, Total : 45

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.

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

CO1 Explain the importance of geometrical tolerances in manufacturing-oriented design
CO2 Describe the design guidelines for manufacturing and assembly-oriented design
CO3 Discuss various form design aspects of different materials.
CO4 Identify and explain the machining and casting considerations for manufacturing-oriented design
CO5 Describe the design on environment to achieve eco-friendly component design.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2						2		2	3	
CO 2	3	3	3	1						2		2	3	
CO 3	3	3	3	1						3		2	3	
CO 4	3	3	3							2		2	3	
CO 5	3	3	3	3			3			1		2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE63	ROBOTICS	L	T	P	C
		3	0	0	3

Pre-requisites: Mechatronics

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.

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.

Lecture: 45, Total: 45

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.

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

CO1 Explain the functions of the basic components of robots.
CO2 Explain the various types of robot drive systems and end effectors.
CO3 Discuss the various types of sensors and machine vision with their applications.
CO4 Identify the concepts of machine vision and robot kinematics.
CO5 Perform robotic programming for accomplishing a particular task.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2		2							2	2	
CO 2	3	2	2		3							2	2	
CO 3	3	2	2		1							2	2	
CO 4	3	2	2		3							2	2	
CO 5	3	2	2		1	2						2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE64	NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

UNIT 1 BASICS AND SCALE OF NANOTECHNOLOGY 9

Importance of Nanotechnology - History of Nanotechnology- Opportunity at the nano scale-length and time scale in structures-energy landscapes - Inter dynamic aspects of intermolecular 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 SYNTHESIS 9

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 9

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 NANOCOMPOSITES AND NANOFLUIDICS 9

Overview of Nanocomposites - Metal Matrix composites: Fabrication Techniques – Solid State Methods – Semi- Solid state Methods – Liquid State Methods. Polymer Matrix Nanocomposites: Solution Mixing Method – Melt Mixing Method – Insitu Polymerization – Electrospinning – Selective Laser Sintering Technique. Properties: Mechanical Testing – Wear Properties – Permeability – Thermal Stability – Flammability. Nano Fluidics: Synthesis – Properties – Applications.

Lecture: 45, Total: 45

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.

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

CO1 Discuss with the basic sciences required to understand the fundamentals of Nanomaterial.

CO2 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.

CO3 Interpret a sound knowledge of the various concepts involved in fabrication of device architectures and able to evaluate them in advance.

CO4 Demonstrate the imaging techniques involved for Nano technology.

CO5 Select appropriate materials and fabrication techniques to prepare nanocomposites and nanofluidics for desired applications.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1										2	2	
CO 2	3	1	3									2	2	
CO 3	3	1	3									2	2	
CO 4	2	1		3								2	2	
CO 5	2	1				2						2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE65	BIOMECHANICS	L	T	P	C
		3	0	0	3

Pre-requisites: Engineering Mechanics

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.

UNIT 1 FUNDAMENTALS OF BIOMECHANICS **9**

Application of the laws of mechanics governing forces and motion in the context of orthodontics & orthopaedic concern material properties such as- stress, strain, stiffness, springiness, and elastic limit of wire. Concepts such as forces, moments and couples, centre of resistance and centre 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 orthopaedic 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, Intrinsic properties -Density, compressibility and surface tension, 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.

Lecture : 45, Total : 45

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, 2012.

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.

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

CO1 Define and use concepts of laws of mechanics to evaluate material properties of simple problems.

CO2 Draw free body diagram and apply static equilibrium to the human body.

CO3 Design implants and Select bio compatibility materials and describe the manufacturing process.

CO4 Apply principles of kinetics applied to the human body.

CO5 Explain the influence of ergonomic principles on work organization.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	2		3					1	2	3	
CO 2	3	2	2	2		3				3		2	3	
CO 3	3	2	3	2		3						2	3	
CO 4	3	2	2	2		3						2	3	
CO 5	3	2	2	2		2						2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE66 MICRO ELECTRO-MECHANICAL SYSTEMS

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Preamble

MEMS are composed of parts such as microsensors, microprocessors, micro actuators, units for data processing and parts that can interact with exterior pieces.

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 ELECTROSTATIC SENSORS **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 PIEZORESISTIVE SENSORS **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.

Lecture : 45, Total : 45

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.

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

CO1 Identify the various characteristics of MEMS
CO2 Ability to understand the operation of micro devices, micro systems and their applications.
CO3 Understand the various sensors and its applications.
CO4 Ability to design the micro devices, micro systems using the MEMS fabrication process
CO5 Identify the polymers used in MEMS and its applications

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2										2	3	
CO 2	3	3	3		2							2	3	
CO 3	3	2	2		2							2	3	
CO 4	3	3	2		2							2	3	
CO 5	3	2										2	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEE67	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

UNIT 1 FRICTION **9**

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 **9**

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 **9**

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 **9**

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 HYDROSTATIC LUBRICATION **9**

Introduction to hydrostatic lubrication, hydrostatic step bearings, load carrying capacity and oil flow through the hydrostatic step bearing, numerical examples. Introduction to Hydrostatic journal bearings.

Lecture : 45, Total : 45

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.

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

CO1 Demonstrate the various theories and practice on Surface Engineering.
CO2 Apply measurement techniques and carry out characterization of industrial coated surfaces.
CO3 Describe standard methods of testing of modified surfaces.
CO4 Describe various surface coating technologies and their applications in industry.
CO5 Able to solve the industrial practical problems in hydrostatic lubrication that arise and also for the research.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3									2	2	
CO 2	3	3	1									2	2	
CO 3	3	3	2									2	2	
CO 4	3	1	3									2	2	
CO 5	3	2										2	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO01	INDUSTRIAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

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

UNIT 1 PRESSURE MEASUREMENT DEVICES **9**

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 **9**

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 – 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 **9**

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

Lecture: 45, Total: 45

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

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

CO1	Discuss the principles of Pressure, Temperature, flow, level, density and viscosity measurements
CO2	Measure the temperature of the given system using thermometer, thermocouple and pyrometer.
CO3	Explain the principle and working of accelerometers and densitometers.
CO4	Describe the working of visual, resistance based, capacitance based, thermal based and vibrating type level measurement instruments.
CO5	Measure the flow of given fluid using pitot tubes, venturi meter, anemometer and ultrasonic flow meter.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1		2	3								2		
CO 2	3		3	3								2		
CO 3	2		1	3								2		
CO 4	2		2	3								2		
CO 5	2		2	3								2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO02	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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 environment. Engage in professional ethics and development. Enrich their society and environment through their skills.

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. Establishing markets - market segments- relevance of market research

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. Competitive benchmarking

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. Case Studies

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. Introduction to Design for Manufacturing & Assembly - Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Case Studies

UNIT 5 PROTOTYPING , PRODUCT DEVELOPMENT ECONOMICS **9**

Prototyping basics, principles of prototyping technologies, planning for prototypes. Introduction to 3D printing. Elements of economic analysis. Sensitive analysis, project trade-offs, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, project evaluation.

Lecture: 45, Total : 45

TEXT BOOKS:

1. Karl T Ulrich, Steven D Eppinger, “Product Design & Development.” Tata McGraw hill 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.

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

CO1 Discuss the concept and stages involved in a generic product development process.

CO2 Identify the customer needs and establish the product specifications.

CO3 Identify concept generation activities and apply design for manufacturing concepts in estimating manufacturing costs.

CO4 Explain the concepts of product architecture and identify the ways to reduce the product cost.

CO5 Apply principles of prototyping in product development economics and effectively manage the product development projects.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		2			2	3					2		
CO 2	3	2	3	2		2	2		3	3	2	2		
CO 3	3	2	3	2		2	2		3	3	2	2		
CO 4	2	2	3	2		2	2		2	2	2	2		
CO 5	3	2	3	2		2	2		3	3	3	3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO03	SUSTAINABLE MANUFACTURING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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- Building Information Management.

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- - Sustainability awareness -Sustainability drivers and barriers.

Lecture : 45, Total : 45

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.

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

CO1 Identify and explain the need for sustainability practices in manufacturing of products to meet development challenges.

CO2 Apply the principles of design for environment in developing ecofriendly products.

CO3 Explain the link between manufacturing process models and sustainable manufacturing metrics for product and process improvement

CO4 Apply economic, environmental, and social aspects into decision making processes using multi-criteria decision making methods.

CO5 Explain the sustainability practices at global, regional and national levels.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		2	1		2	3	2			2	2		
CO 2	3		3	2		3	3	3	3	3	2	2		
CO 3	2		1			2	3	2			2	2		
CO 4	3		1	1		3	3	3			2	2		
CO 5	3		3	2		3	3	3			2	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO04	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

Pre-requisites: Basic Knowledge on Principles of Management.

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.

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 MANAGEMENT **9**

Small scale enterprises – Definition, Business ownership structures – Project formulation – Steps involved in setting up a business – Identifying, selecting a good business opportunity-Startups.
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. Ratio Analysis –analysis of liquidity, leverage, profitability and activity; Fund flow analysis-uses and construction of Funds flow statement; Cash flow analysis-Uses and preparation of cash flow statement

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.

Lecture: 45, Total: 45

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

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.

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

CO1 Identify the role of Entrepreneurship and study the factors affecting entrepreneurial growth.
CO2 Apply motivational techniques for effective stress management in entrepreneurship development.
CO3 Identify ownership structures for better project formulation and business growth.
CO4 Apply knowledge on sources of finance for managing working capital.
CO5 Identify support institutions for the given company.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1								2	2	2	2			
CO 2			2			3		3	3	3	2	2		
CO 3	2	2	2	2				2	2	2	2	2		
CO 4	3	2		2				3	3	3	2	2		
CO 5	1	1						2	2	2	1	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO05	FUNDAMENTALS OF ERGONOMICS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

This course provides the basic concepts of ergonomics and various tools and techniques involved in designing comfortable and safe workplace.

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 - Preventing Ergonomically Related Injuries by Redesigning the Workplace; Fitting the workplace to the worker. Occupational / Ergonomic safety and stress at various workplace - health management rules - Scope of Ergonomics in India-case studies.

Lecture: 45, Total : 45

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

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

CO1 Define ergonomics and its components.
CO2 Make use of statistical treatment of data in designing the components of office and shop floor.
CO3 Assess the common risk factors and areas for ergonomic improvement.
CO4 Apply ergonomic principles in framing work content for workers.
CO5 Plan the essential elements for an effective ergonomics programme.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2		3	2		1						3		
CO 2	2	2	3	3	2	2						3		
CO 3	2	2	3	2		2						3		
CO 4	2		3			2	2			2		3		
CO 5	2	2	3	2	2	3						3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO06	PRINCIPLES OF MANAGEMENT AND INDUSTRIAL PSYCHOLOGY	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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 – Types of business organization - Sole proprietorship, partnership, Company-public and private sector enterprises – Current trends and issues in 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- Transactional Analysis and Johari Window

Lecture: 45, Total : 45

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. John W Newstrom, : Organizational Behavior : Human Behavior at work,12 th Edition, McGraw -Hill, 2017.

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

CO1 Interpret the theory and the practice of management.
CO2 Demonstrate knowledge and understanding of the functions of management.
CO3 Define organizational behaviour and explain how managers create organizational culture.
CO4 Develop an intuitive understanding of the science of human behavior and the art of managing groups.
CO5 Develop ability for solving problems involving employee - industry relationship.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2					2		1	2	2	2	2		
CO 2	2	2		2		2		1	2	2	2	2		
CO 3	2		2			2	2	1	2	2	2	2		
CO 4	2					2		1	3	3	2	2		
CO 5	2					2		1	3	3	2	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEO07	SAFETY MEASURES FOR ENGINEERS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

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- Case studies

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.-computer equipment safety

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 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 - 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-case studeis

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.

Lecture : 45, Total : 45

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.

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

CO1	Perceive the safety management concepts and accident prevention methods.
CO2	Apply appropriate measuring and /or insulating equipment, use of fire extinguishers and safe earthing practices.
CO3	Identify the different source of ignition and their prevention techniques
CO4	Select the PPE based on the type of industry and standards.
CO5	Implement the techniques like risk assessment disaster management and emergency preparedness with the proper knowledge on accident prevention.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2		2		3	2	2	3	3	2	2		
CO 2	2			2	2	3		2				2		
CO 3	2			2		3		2				2		
CO 4	2			2		3		2				2		
CO 5	2	2		2		3		2		2		2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEV01	FINITE ELEMENT SIMULATION USING COMMERCIAL ANALYSIS PACKAGES	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Get familiarized with the basic concepts of solid mechanics.
CO2 Use ANSYS FEA for numerical simulation.
CO3 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

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.

22MEV02	GEOMETRIC DIMENSIONING AND TOLERANCING	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Describe the terminology and various elements in GD&T as per standards.
CO2 Illustrate the various type of tolerances and fits.
CO3 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

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.

22MEV03 CAM USING COMMERCIAL SOFTWARE PACKAGES

L	T	P	C
0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Create tool path for basic operations.
CO2 Create tool path for 2D machining operations
CO3 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

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.

22MEV04	ADVANCED MODULES FOR DESIGN ENGINEERS USING CAD PACKAGES	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Design and create Part Models and Complex Assembly Models
CO2 Apply the concepts of sheet metal design.
CO3 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.

Total : 30

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

22MEV05	PIPING DESIGN AND ENGINEERING	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Understand the basic piping requirements for design as per the international codes & standards.
CO2 Identify the basic components for the cost effective new installation.
CO3 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

REFERENCES:

1. Shrivastav A, "**Fundamentals of Pipeline Engineering", Scitus academics, 2016.**
2. Rangwala A S, "Piping dynamics", New age International Publishers, 2016.

22MEV06	FIXTURE DESIGN	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Understand the concepts, purpose of Fixture Design in Industries.
CO2 Apply the Step by Step Procedure for Milling (VMC) Fixture Design.
CO3 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

REFERENCES:

1. Course Manual Provided by Kriatec Services (P) Limited and NEAT-AICTE

22MEV07	MACHINE LEARNING FOR MECHANICAL ENGINEERS	L	T	P	C
		0	0	2	1

Pre-requisites: 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 this course, students will be able to:

CO1 Define the basic terminology and and classify the techniques of machine learning.

CO2 Classify and explain the neural networks and evolutionary optimization techniques.

CO3 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

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.

22MEM21	FOUNDATIONS OF ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

Pre-requisites: Entrepreneurship Development

Preamble

Foundations in Entrepreneurship covers Traits and Skills of an Entrepreneur, Personal Growth, Business Finance (Resource Management, Profit/Loss, Giving Back), Business Marketing (Products, Selling, Branding), and Business Management (Growing Your Business, Human Resources, Business Plans, and Information Technology).

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.

Lecture : 45, Total : 45

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

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

CO1 Learn the basics of Entrepreneurship
CO2 Understand the business ownership patterns and environment
CO3 Understand the Job opportunities in Industries relating to Technopreneurship
CO4 Learn about applications of technopreneurship and successful technopreneurs
CO5 Acquaint with the recent and emerging trends in entrepreneurship

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1								2	2	2	2	2		
CO 2			2			3		3	3	3	2	2		
CO 3	2	2	2	2				2	2	2	2	2		
CO 4	3	2		2				3	3	3	2	2		
CO 5	2	2						2	2	2	2	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEM22	TEAM BUILDING AND LEADERSHIP MANAGEMENT FOR BUSINESS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

Team building is the constant strive to enhance the relationships between employees and help them collaborate in the most effective way possible. And team leaders play a key role in this. Essentially, leaders are responsible for taking individual employees and bringing them together as a cohesive team.

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.

Lecture: 45, Total: 45

TEXT BOOKS:

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).

REFERENCES:

1. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
2. Daft, R.L., The Leadership Experience, Cengage, (2015).
3. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.

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

CO1 Learn the basics of managing teams for business.
CO2 Understand developing effective teams for business management.
CO3 Understand the fundamentals of leadership for running a business.
CO4 Learn about the importance of leadership for business development
CO5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	1						2	3	2	2	2		
CO 2	2	1						2	3	2	2	2		
CO 3	2	1						2	3	2	2	2		
CO 4	2	1						2	3	2	2	2		
CO 5	2	1						2	3	2	2	2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEM23 CREATIVITY AND INNOVATION IN ENTREPRENEURSHIP

L	T	P	C
3	0	0	3

Pre-requisites: Entrepreneurship Development

Preamble

Creativity and innovation have become vital points to enhance the value of entrepreneurship. Creativity helps to improve existing business practices. Innovation is about making a process that can convert invention or gain idea to become more marketable product or service.

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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand,2021
2. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

REFERENCES:

1. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018
2. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014
3. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

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

CO1	Learn the basics of creativity for developing Entrepreneurship
CO2	Understand the importance of creative intelligence for business growth
CO3	Understand the advances through Innovation in Industries
CO4	Learn about applications of innovation in building successful ventures
CO5	Acquaint with developing innovative business models to run the business efficiently and effectively

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	1				3		2	3	2	2	3		
CO 2	2	1				3		2	3	2	2	3		
CO 3	2	1				3		2	3	2	2	3		
CO 4	2	1				2		2	3	2	2	3		
CO 5	2	1				2		2	3	2	2	3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEM24	PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

Marketing management principles can help businesses achieve their marketing objectives. Some principles of marketing management include: Customer focus, Value creation, Marketing mix, Integrated marketing communications, Strategic planning, Innovation.

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

Lecture : 45, Total : 45

TEXT BOOKS:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management, Philip Kortler and Kevin Lane Keller, PHI 15th Ed, 2015

REFERENCES:

1. Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
2. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy &S.Namakumari, Macmillan Publishers India,5th edition, 2015
3. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India

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

CO1 Have the awareness of marketing management process
CO2 Understand the marketing environment
CO3 Acquaint about product and pricing strategies
CO4 Knowledge of promotion and distribution in marketing management.
CO5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2			3	1		2	2	2	2	3		
CO 2	3	2			3	1		2	2	2	2	3		
CO 3	3	2			3	1		2	2	2	2	3		
CO 4	3	2			3	1		2	2	2	2	3		
CO 5	3	2			3	1		2	2	2	2	3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEM25 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Preamble

Human resource management is a leadership function within an organization that helps to align the workforce with the beliefs, intentions and goals of an organization.

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

Lecture : 45, Total : 45

TEXT BOOKS:

1. Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
2. Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.

REFERENCES:

1. David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
2. R. Wayne Mondy, Human Resource Management, Pearson , 2015.
3. Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012

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

CO1 To understand the Evolution of HRM and Challenges faced by HR Managers
CO2 To learn about the HR Planning Methods and practices
CO3 To acquaint about the Recruitment and Selection Techniques followed in Industries
CO4 To known about the methods of Training and Employee Development.
CO5 To comprehend the techniques of controlling human resources in organisations

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3					3		3	2	2	2	3		
CO 2	3					3		3	2	2	2	3		
CO 3	3					3		3	2	2	2	3		
CO 4	3					3		3	2	2	2	3		
CO 5	3					3		3	2	2	2	3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MEM26	FINANCING NEW BUSINESS VENTURES	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

Financing a new venture employs a combination of debt and equity financing. Debt is presumed to be lower-risk capital because it is repaid according to a set schedule of principal and interest. Debt financing involves an interest-bearing instrument usually called a loan.

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

Lecture : 45, Total : 45

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.

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

CO1 Learn the basics of starting a new business venture
CO2 Understand the basics of venture financing.
CO3 Understand the sources of debt financing.
CO4 Understand the sources of equity financing.
CO5 Acquaint with the methods of fund raising for new business ventures.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3				2	2	2	2	2	3	3		
CO 2	3	3				2	2	2	2	2	3	3		
CO 3	3	3				2	2	2	2	2	3	3		
CO 4	3	3				2	2	2	2	2	3	3		
CO 5	3	3				2	2	2	2	2	3	3		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).