Curriculum and Syllabi

B.E. MECHANICAL ENGINEERING

SEMESTERS I to VIII

Regulations 2022

Programme: B.E. MECHANICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

Curriculum for Semesters I to VIII

SEMESTER I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
2.	22CS101	Problem Solving Techniques I	3	0	2	5	4	60 / 40	ES
3.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES
Theory Courses									
4.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
5.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
6.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
7.	22ME101	Engineering Mechanics	3	0	0	3	3	60 / 40	PC
8.	22ME102	Engineering Graphics	2	0	2	4	3	60 / 40	PC
Mandatory Course									
9.		Student Induction Programme							MC

SEMESTER II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22CH101	Engineering Chemistry	3	0	2	5	4	60 / 40	BS
2.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES
Theory Courses									
3.	22HS201	Technical English	3	0	0	3	3	60 / 40	HS
4.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
5.	22HS202	Environmental Science	2	0	0	2	2	60 / 40	HS
6.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC
7.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
8.	22EE102	Basics of Electrical and Electronics Engineering	3	0	0	3	3	60 / 40	ES
Practical Course									
9.	22ES201	Engineering Practice Laboratory	0	0	4	4	2	40 / 60	ES

SEMESTER III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22CS302	Problem Solving Techniques III	3	0	2	5	4	60/40	ES
2.	22ME301	Strength of Materials	3	0	2	5	4	60/40	PC
3.	22AG302	Fluid Mechanics and	3	0	2	5	4	60/40	ES

		Machinery							
4.	22ME302	Theory of Machines	3	0	2	5	4	60/40	PC
Theory Courses									
5.	22MA301	Transforms and Partial Differential Equations	3	1	0	4	4	60/40	BS
6.	22ME303	Manufacturing Process	3	0	0	3	3	60/40	PC
Practical Course									
7.	22EEC301	Industrial Training / Internship - I	0	0	0	2 Weeks	1	0/100	EEC

SEMESTER IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22ME401	Manufacturing Technology	3	0	2	5	4	60/40	PC
Theory Courses									
2.	22MA303	Probability and Statistics	3	1	0	4	4	60/40	BS
3.	22ME402	Engineering Thermodynamics	3	0	0	3	3	60/40	PC
4.	22ME403	Engineering Materials and Metallurgy	3	0	0	3	3	60/40	PC
Elective Course									
5.		Open Elective - I					3	60/40	OE
Practical Course									
6.	22ME404	Computer Aided Machine Drawing	0	0	4	4	2	40/60	ES
Mandatory Course									
7.	22MC404	Project – Worth out of Waste					-	0/100	MC

SEMESTER V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22ME501	Thermal Engineering	3	0	2	5	4	60/40	PC
2.	22ME502	Metrology and Measurements	3	0	2	5	4	60/40	PC
Theory Course									
3.	22ME503	Design of Machine Elements	3	0	0	3	3	60/40	PC
Elective Courses									
4.		Professional Elective – I					3	60/40	PE
5.		Open Elective - II					3	60/40	OE
6.		Open Elective - III					3	60/40	OE
Practical Course									
7.	22ME504	Computer Aided Modeling Lab	0	0	4	4	2	40/60	PC
8.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0/100	EEC
Mandatory Course									
9.	22MC502	Industrial Safety					-	0/100	MC

SEMESTER VI

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22ME601	Heat and Mass Transfer	3	0	2	5	4	60/40	PC
2.	22ME602	Finite Element	3	0	2	5	4	60/40	PC

		Analysis							
Theory Course									
3.	22ME603	Hydraulics and Pneumatics	3	0	0	3	3	60/40	PC
Elective Courses									
4.		Professional Elective –II					3	60/40	PE
5.		Open Elective-IV					3	60/40	OE
Practical Course									
6.	22EEC503	Mini Project	0	0	4	4	2	40 / 60	EEC

SEMESTER VII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22ME701	Mechatronics and IoT	3	0	2	5	4	60/40	ES
Theory Course									
2.	22HS702	Human Values and Ethics	3	0	0	3	3	60/40	HS
Elective Courses									
3.		Professional Elective – III					3	60/40	PE
4.		Professional Elective –IV					3	60/40	PE
5.		Open Elective – V					3	60/40	OE
Practical Course									
6.	22EEC701	Project Work – Phase I	0	0	4	4	2	0/100	EEC

SEMESTER VIII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Course									
1.	22MG801	Industrial	3	0	0	3	3	60/40	HS

		Management							
Elective Course									
2.		Professional Elective – V					3	60/40	PE
Practical Course									
3.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

Total Credits : 165

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SUMMARY

S.No	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS		5					3	3	11
2	BS	8	8	4	4					24
3	ES	6	9	8	2			4		29
4	PC	6		11	10	13	11			51
5	PE					3	3	6	3	15
6	OE				3	6	3	3		15
7	EEC	1	1	1		1	2	2	10	18
8	AC	1	1							2
	Total	22	24	24	19	23	19	18	16	165
9	MC (Non Credit)	~			~	~				

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22HS201	Technical English	3	0	0	3	3	60 / 40	HS
2.	22HS202	Environmental Science	2	0	0	2	2	60 / 40	HS
3.	22HS702	Human Values and Ethics	3	0	0	3	3	60/40	HS
4.	22MG801	Industrial Management	3	0	0	3	3	60/40	HS

BASIC SCIENCES (BS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
2.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
3.	22CH101	Engineering Chemistry	3	0	2	5	4	60 / 40	BS
4.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
5.	22MA301	Transforms and Partial Differential Equations	3	1	0	4	4	60/40	BS
6.	22MA303	Probability and Statistics	3	1	0	4	4	60/40	BS

ENGINEERING SCIENCES (ES)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22CS101	Problem Solving Techniques I	3	0	2	5	4	60 / 40	ES

2.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES
3.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES
4.	22EE102	Basics of Electrical and Electronics Engineering	3	0	0	3	3	60 / 40	ES
5.	22ES201	Engineering Practice Laboratory	0	0	4	4	2	40 / 60	ES
6.	22CS302	Problem Solving Techniques III	3	0	2	5	4	60/40	ES
7.	22AG302	Fluid Mechanics and Machinery	3	0	2	5	4	60/40	ES
8.	22ME404	Computer Aided Machine Drawing	0	0	4	4	2	40/60	ES
9.	22ME701	Mechatronics and IoT	3	0	2	5	4	60/40	ES

PROFESSIONAL CORE (PC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22ME101	Engineering Mechanics	3	0	0	3	3	60 / 40	PC
2.	22ME102	Engineering Graphics	2	0	2	4	3	60 / 40	PC
3.	22ME301	Strength of Materials	3	0	2	5	4	60/40	PC
4.	22ME302	Theory of Machines	3	0	2	5	4	60/40	PC
5.	22ME303	Manufacturing Process	3	0	0	3	3	60/40	PC
6.	22ME401	Manufacturing Technology	3	0	2	5	4	60/40	PC
7.	22ME402	Engineering Thermodynamics	3	0	0	3	3	60/40	PC

8.	22ME403	Engineering Materials and Metallurgy	3	0	0	3	3	60/40	PC
9.	22ME501	Thermal Engineering	3	0	2	5	4	60/40	PC
10.	22ME502	Metrology and Measurements	3	0	2	5	4	60/40	PC
11.	22ME503	Design of Machine Elements	3	0	0	3	3	60/40	PC
12.	22ME504	Computer Aided Modeling Lab	0	0	4	4	2	40/60	PC
13.	22ME601	Heat and Mass Transfer	3	0	2	5	4	60/40	PC
14.	22ME602	Finite Element Analysis	3	0	2	5	4	60/40	PC
15.	22ME603	Hydraulics and Pneumatics	3	0	0	3	3	60/40	PC

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
2.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
3.	22EEC301	Industrial Training / Internship - I	0	0	0	2 Weeks	1	0/100	EEC
4.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0/100	EEC
5.	22EEC503	Mini Project	0	0	4	4	2	40 / 60	EEC
6.	22EEC701	Project Work – Phase I	0	0	4	4	2	0/100	EEC
7.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

AUDIT COURSES (AC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
2.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC

NON CREDIT MANDATORY COURSES (NCMC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.		Student Induction Programme							MC
2.	22MC404	Project – Worth out of Waste					-	0/100	MC
3.	22MC502	Industrial Safety					-	0/100	MC

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Professional Electives

Professional Elective I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME01	Automobile Engineering	3	0	0	3	3	60/40	PE
2.	22PME02	Welding Technology	3	0	0	3	3	60/40	PE
3.	22PME03	Robotics	3	0	0	3	3	60/40	PE
4.	22PBM32	Intellectual Property Rights	3	0	0	3	3	60/40	PE
5.	22PME04	Drone Technologies	3	0	0	3	3	60/40	PE

Professional Elective II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME05	Power Plant Engineering	3	0	0	3	3	60/40	PE
2.	22PME06	Gas Dynamics and Jet Propulsion	3	0	0	3	3	60/40	PE
3.	22PME07	Refrigeration and Air Conditioning	3	0	0	3	3	60/40	PE
4.	22PME08	Turbo machinery	3	0	0	3	3	60/40	PE
5.	22PME09	Internal Combustion Engine	3	0	0	3	3	60/40	PE

Professional Elective III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME10	Design of Transmission System	3	0	0	3	3	60/40	PE
2.	22PME11	Dynamics of Machines	3	0	0	3	3	60/40	PE
3.	22PME12	Computer Aided Design	3	0	0	3	3	60/40	PE
4.	22PME13	Design of Jigs, Fixtures and Press Tools	3	0	0	3	3	60/40	PE
5.	22PME14	Tool Design	3	0	0	3	3	60/40	PE

Professional Elective IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME15	Production Planning and Control	3	0	0	3	3	60/40	PE
2.	22PME16	Process Planning and Cost Estimation	3	0	0	3	3	60/40	PE
3.	22PME17	Non Destructive Testing and Evaluation	3	0	0	3	3	60/40	PE
4.	22PME18	Quality Control and Reliability Engineering	3	0	0	3	3	60/40	PE
5.	22PME19	Lean Manufacturing	3	0	0	3	3	60/40	PE

Professional Elective V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME20	Total Quality Management	3	0	0	3	3	60/40	PE
2.	22PME21	Engineering Economics and Financial Accounting	3	0	0	3	3	60/40	PE
3.	22PME22	Energy Storage Devices	3	0	0	3	3	60/40	PE
4.	22PME23	Composite Materials	3	0	0	3	3	60/40	PE
5.	22PME24	Operational Research	3	0	0	3	3	60/40	PE

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Open Electives

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22OME01	Additive Manufacturing	3	0	0	3	3	60 / 40	OE
2.	22OAG01	Agricultural Finance, Banking and Co-Operatives	3	0	0	3	3	60 / 40	OE
3.	22OME03	Air pollution and control engineering	3	0	0	3	3	60 / 40	OE
4.	22OCS01	Artificial Intelligence and Machine Learning Fundamentals	3	0	0	3	3	60 / 40	OE
5.	22OME04	Automotive Systems	3	0	0	3	3	60 / 40	OE
6.	22OME06	Concepts in Mobile Robotics	3	0	0	3	3	60 / 40	OE
7.	22OCS13	Data Structures	3	0	0	3	3	60 / 40	OE
8.	22OCS14	Database Management Systems	3	0	0	3	3	60 / 40	OE
9.	22OME08	Digital Manufacturing	3	0	0	3	3	60 / 40	OE
10.	22OME10	Entrepreneurship Development	3	0	0	3	3	60 / 40	OE
11.	22OAG07	Environment & Agriculture	3	0	0	3	3	60 / 40	OE
12.	22OME11	Environmental and Social Impact Assessment	3	0	0	3	3	60 / 40	OE
13.	22OME12	Industrial Design & Rapid	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
		Prototyping Techniques							
14.	22OME13	Industrial IoT and Industry 4.0	3	0	0	3	3	60 / 40	OE
15.	22OEC12	Introduction to MEMS and NEMS	3	0	0	3	3	60 / 40	OE
16.	22OEC13	IoT Concepts and Applications	3	0	0	3	3	60 / 40	OE
17.	22OME18	Lean Six Sigma	3	0	0	3	3	60 / 40	OE
18.	22OME19	Low Cost Automation	3	0	0	3	3	60 / 40	OE
19.	22OME21	Micro and Precision Engineering	3	0	0	3	3	60 / 40	OE
20.	22OEC17	Nano Technology and Its Applications	3	0	0	3	3	60 / 40	OE
21.	22OME23	Plant Layout and Material Handling	3	0	0	3	3	60 / 40	OE
22.	22OBT09	Principles of food processing	3	0	0	3	3	60 / 40	OE
23.	22OME24	Process modeling and Simulation	3	0	0	3	3	60 / 40	OE
24.	22OME25	Product Design and Development	3	0	0	3	3	60 / 40	OE
25.	22OME26	Production and Operations management for Entrepreneurs	3	0	0	3	3	60 / 40	OE
26.	22OME27	Production Technology of Agricultural machinery	3	0	0	3	3	60 / 40	OE
27.	22OME30	Renewable Energy Resources	3	0	0	3	3	60 / 40	OE
28.	22OEC21	Sensors and Actuators	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
29.	22OME35	Vehicle Styling and Design	3	0	0	3	3	60 / 40	OE

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Verticals

Vertical I : MODERN MOBILITY SYSTEMS

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME25	Automotive Materials, Components, Design & Testing	2	0	2	4	3	60/40	PE
2.	22PME26	Conventional and Futuristic Vehicle Technology	3	0	0	3	3	60/40	PE
3.	22PME27	Renewable Powered Off Highway Vehicles and Emission Control Technology	3	0	0	3	3	60/40	PE
4.	22PME28	Vehicle Health Monitoring, Maintenance and Safety	3	0	0	3	3	60/40	PE
5.	22PME29	CAE and CFD Approach in Future Mobility	2	0	2	4	3	60/40	PE
6.	22PME30	Hybrid and Electric Vehicle Technology	3	0	0	3	3	60/40	PE
7.	22PME31	Thermal Management of Batteries and Fuel Cell	3	0	0	3	3	60/40	PE

Vertical II : PRODUCT AND PROCESS DEVELOPMENT

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME32	Value Engineering	3	0	0	3	3	60/40	PE
2.	22PME33	Additive Manufacturing	2	0	2	4	3	60/40	PE
3.	22PME34	CAD/CAM	3	0	0	3	3	60/40	PE
4.	22PME35	Design For X	3	0	0	3	3	60/40	PE
5.	22PME36	Ergonomics in Design	3	0	0	3	3	60/40	PE
6.	22PME37	New Product Development	3	0	0	3	3	60/40	PE
7.	22PME38	Product Life Cycle Management	3	0	0	3	3	60/40	PE

Vertical III : ROBOTICS AND AUTOMATION

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME39	Sensors and Instrumentation	3	0	0	3	3	60/40	PE
2.	22PME40	Electrical Drives and Actuators	3	0	0	3	3	60/40	PE
3.	22PME41	Embedded Systems and Programming	2	0	2	4	3	60/40	PE
4.	22PME03	Robotics	3	0	0	3	3	60/40	PE
5.	22PME42	Smart Mobility and Intelligent Vehicles	3	0	0	3	3	60/40	PE
6.	22PME43	Haptics and Immersive Technologies	3	0	0	3	3	60/40	PE
7.	22PME04	Drone Technologies	3	0	0	3	3	60/40	PE

Vertical IV : DIGITAL AND GREEN MANUFACTURING

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME44	Digital Manufacturing and IoT	2	0	2	4	3	60/40	PE
2.	22PME19	Lean Manufacturing	3	0	0	3	3	60/40	PE
3.	22PME45	Modern Robotics	2	0	2	4	3	60/40	PE
4.	22PME46	Green Manufacturing Design and Practices	3	0	0	3	3	60/40	PE
5.	22PME47	Environment Sustainability and Impact Assessment	3	0	0	3	3	60/40	PE
6.	22PME48	Energy Saving Machinery and Components	3	0	0	3	3	60/40	PE
7.	22PME49	Green Supply Chain Management	3	0	0	3	3	60/40	PE

Vertical V : PROCESS EQUIPMENT AND PIPING DESIGN

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME50	Design of Pressure Vessels	3	0	0	3	3	60/40	PE
2.	22PME51	Failure Analysis and NDT Techniques	2	0	2	4	3	60/40	PE
3.	22PME52	Material Handling and solid processing Equipment	3	0	0	3	3	60/40	PE

4.	22PME53	Rotating Machinery Design	3	0	0	3	3	60/40	PE
5.	22PME54	Thermal and Fired Equipment design	3	0	0	3	3	60/40	PE
6.	22PME55	Industrial Layout Design and Safety	2	0	2	4	3	60/40	PE
7.	22PME56	Design Codes and Standards	3	0	0	3	3	60/40	PE

Vertical VI : CLEAN AND GREEN ENERGY TECHNOLOGIES

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME57	Bioenergy Conversion Technologies	3	0	0	3	3	60/40	PE
2.	22PME58	Carbon Footprint estimation and reduction techniques	3	0	0	3	3	60/40	PE
3.	22PME59	Energy Conservation in Industries	3	0	0	3	3	60/40	PE
4.	22PME60	Energy Efficient Buildings	3	0	0	3	3	60/40	PE
5.	22PME22	Energy Storage Devices	3	0	0	3	3	60/40	PE
6.	22PME61	Renewable Energy Technologies	3	0	0	3	3	60/40	PE
7.	22PME62	Equipment for Pollution Control	3	0	0	3	3	60/40	PE

Vertical VII : COMPUTATIONAL ENGINEERING

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME63	Computational Solid Mechanics	3	0	0	3	3	60/40	PE
2.	22PME64	Computational Fluid Dynamics and Heat transfer	3	0	0	3	3	60/40	PE
3.	22PME65	Theory on Computation and Visualization	3	0	0	3	3	60/40	PE
4.	22PME66	Computational Bio-Mechanics	3	0	0	3	3	60/40	PE
5.	22PME67	Advanced Statistics and Data Analytics	3	0	0	3	3	60/40	PE
6.	22PME68	CAD and CAE	2	0	2	4	3	60/40	PE
7.	22PME69	Machine Learning for Intelligent Systems	3	0	0	3	3	60/40	PE

Vertical VIII : DIVERSIFIED COURSES GROUP 1

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME01	Automobile Engineering	3	0	0	3	3	60/40	PE
2.	22PME70	Measurements and Controls	3	0	0	3	3	60/40	PE
3.	22PME71	Design Concepts in Engineering	3	0	0	3	3	60/40	PE
4.	22PME72	Composite Materials and Mechanics	3	0	0	3	3	60/40	PE

5.	22PME73	Electrical Drives and Control	3	0	0	3	3	60/40	PE
6.	22PME05	Power Plant Engineering	3	0	0	3	3	60/40	PE
7.	22PME07	Refrigeration and Air Conditioning	3	0	0	3	3	60/40	PE
8.	22PME74	Dynamics of Ground Vehicles	3	0	0	3	3	60/40	PE

Vertical IX : DIVERSIFIED COURSES GROUP 2

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME75	Turbo Machines	3	0	0	3	3	60/40	PE
2.	22PME76	Non-traditional Machining Processes	3	0	0	3	3	60/40	PE
3.	22PBT25	Industrial safety	3	0	0	3	3	60/40	PE
4.	22PME10	Design of Transmission System	3	0	0	3	3	60/40	PE
5.	22PME77	Thermal Power Engineering	3	0	0	3	3	60/40	PE
6.	22PME78	Design for Manufacturing	3	0	0	3	3	60/40	PE
7.	22PME79	Power Generation Equipment Design	3	0	0	3	3	60/40	PE

Vertical X : DIVERSIFIED COURSES GROUP 3

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PME80	Advanced Vehicle	3	0	0	3	3	60/40	PE

		Engineering							
2.	22PME81	Advanced Internal Combustion Engineering	3	0	0	3	3	60/40	PE
3.	22PME82	Casting and Welding Processes	3	0	0	3	3	60/40	PE
4.	22PME16	Process Planning and Cost Estimation	3	0	0	3	3	60/40	PE
5.	22PME83	Surface Engineering	3	0	0	3	3	60/40	PE
6.	22PME84	Precision Manufacturing	3	0	0	3	3	60/40	PE
7.	22PME06	Gas Dynamics and Jet Propulsion	3	0	0	3	3	60/40	PE
8.	22PME24	Operational Research	3	0	0	3	3	60/40	PE

22PH101	ENGINEERING PHYSICS	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To make the students effectively achieve an understanding of mechanics and properties of matter.
2. To enable the students to gain knowledge of electromagnetic waves.
3. To introduce the basics of solid-state physics.
4. Equipping the students to successfully understand the importance of optics and Laser.
5. To motivate the students towards the applications of quantum mechanics.
6. To learn problem solving skills related to physics principles and interpretation of experimental data.
7. To determine error in experimental measurements and techniques used to minimize such error.

Expected Course Outcome:

1. Understand the importance of mechanics and properties of matter
2. Express their knowledge in electromagnetic waves.
3. Demonstrate a strong foundational knowledge in solid state physics.
4. Gain the knowledge in optics and Laser.
5. Understand the importance of quantum physics and Nanodevices.
6. Understand the functioning of various physics laboratory equipment.
7. Use graphical models to analyze laboratory data.
8. Use mathematical models as a medium for quantitative reasoning and describing physical reality.

Course Content:

UNIT I MECHANICS AND PROPERTIES OF MATTER 9 Hours

Mechanics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy-moment of inertia and its theorem- gyroscope - torsional pendulum.

Elasticity: Elastic modules – Poisson's ratio – relation between them – determination of Young's modulus by uniform and non-uniform bending- I section girders.

UNIT II ELECTROMAGNETIC WAVES 9 Hours

Maxwell's equations (Basics) - Charged particles in uniform and constant electric field – Charged particles in an alternating electric field- polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.

UNIT III SOLID STATE PHYSICS 9 Hours

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators;

conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation.

UNIT IV OPTICS & LASER 9 Hours

Classification of optical materials – carrier generation and recombination processes - insulators and semiconductors (concepts only) - photo current in a P-N diode – solar cell - LED– Laser diodes – Optical data storage techniques.

Laser (Basics)– Einstein's coefficient- Types of Laser- He- Ne Laser - CO_2 laser, Nd-YAG laser, semiconductor laser – MASER Introduction - Holography: Principle and construction - Reconstruction of Holography.

UNIT V QUANTUM MECHANICS & NANODEVICES 9 Hours

Compton effect - The Schrodinger equation (Time dependent and time independent forms)- particle in an infinite potential well: 1D,2D and 3D Boxes.

NanoDevices: Introduction - quantum confinement – quantum structures: quantum wells, wires and dots — band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - resonant- tunneling diode – single electron transistor – quantum cellular automata - Quantum system for information processing.

TOTAL LECTURE HOURS 45 Hours

Text Book(s):

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. Brijlal and N. Subramaniam "Properties of Matter", Eurasia Publishing House Limited, 1993.
3. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ. Press.
4. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGrawHill (Indian Edition), 2017.
5. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

Reference Books:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physics – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson Education (Indian Edition) 2009.

Web Links:

1. https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf
2. https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf

22CS101	PROBLEM SOLVING TECHNIQUES I	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

Expected Course Outcome:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Write simple Python programs using conditionals and loops for solving problems.
4. Decompose a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries etc.
6. Read and write data from/to files in Python programs.

Course Content:

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9 Hours

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 II DATA TYPES, EXPRESSIONS, STATEMENTS 9 Hours

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments;

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9 Hours

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.

UNIT IV LISTS, TUPLES, DICTIONARIES 9 Hours

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;

UNIT V FILES, MODULES, PACKAGES 9 Hours

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages;

TOTAL LECTURE HOURS 45 Hours

Text Book(s):

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

Reference Books:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

Web Links:

1. https://www.python.org/

List of Experiments:

1.	Exchange the values of two variables, circulate the values of n variables, distance between two points.	**3 Hours**
2.	Square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.	**4 Hours**
3.	Simple sorting, histogram, Students marks statement, Retail bill preparation.	**4 Hours**
4.	Word count, copy file, Voter’s age validation, Marks range validation (0-100).	**4 Hours**
	TOTAL PRACTICAL HOURS	**15 Hours**
	TOTAL LECTURE CUM PRACTICAL HOURS	**60 Hours**

22ES101	INNOVATION AND DESIGN THINKING	L	T	P	C
		1	0	2	2

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To explain the concept of design thinking for product and service development
2. To explain the fundamental concept of innovation and design thinking
3. To discuss the methods of implementing design thinking in the real world.

Expected Course Outcome:

1. To immerse students into the world of innovation as a systematic process of tackling relevant business and/or social problems.
2. To provide a social and thinking space for the recognition of innovation challenges and the design of creative.
3. To expose the student with state of the art perspectives, ideas, concepts, and solutions related to the design and execution of innovation driven projects using design thinking principles.
4. To develop an advance innovation and growth mindset form of problem identification and reframing, foresight, hindsight and insight generation.

Course Content:

UNIT I PROCESS OF DESIGN 3 Hours

Understanding Design thinking - Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

UNIT II TOOLS OF DESIGN THINKING 3 Hours

Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design.

UNIT III DESIGN THINKING IN IT 3 Hours

Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping.

UNIT IV DT FOR STRATEGIC INNOVATIONS 3 Hours

Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model design.

UNIT V DESIGN THINKING WORKSHOP 3 Hours

Design Thinking Workshop Empathize, Design, Ideate, Prototype and Test.

TOTAL LECTURE CUM PRACTICAL HOURS 15 Hours

Text Book(s):

1. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design",Cengage learning (International edition) Second Edition, 2013.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
3. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011.
4. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Reference Books:

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", CengageLearning, Second Edition, 2011.
2. Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).

22MA101	MATHEMATICS I	L	T	P	C
		3	1	0	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables. This is needed in many branches of engineering.
4. To make the students understand various techniques of integration.
5. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

Expected Course Outcome:

1. At the end of the course the students will be able to Use the matrix algebra methods for solving practical problems.
2. Apply differential calculus tools in solving various application problems.
3. Able to use differential calculus ideas on several variable functions.
4. Apply different methods of integration in solving practical problems.
5. Apply multiple integral ideas in solving areas, volumes and other practical problems.

Course Content:

UNIT I MATRICES 12 Hours

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS 12 Hours

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 III FUNCTIONS OF SEVERAL VARIABLES 12 Hours

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 12 Hours

Definite and Indefinite integrals – Substitution rule – Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction– Improper integrals – Applications: Hydrostatic force

and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS 12 Hours

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.

TOTAL LECTURE CUM TUTORIAL HOURS 60 Hours

Text Book(s):

1. Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.

Reference Books:

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

Web Links:

1. https://www.pdfdrive.com/higher-engineering-mathematics-d18621876.html
2. https://www.pdfdrive.com/advanced-engineering-mathematics-d166759888.html
3. https://theswissbay.ch/pdf/Gentoomen%20Library/Maths/Calculus/Calculus%20-%20Early%20Transcendentals%206e.pdf

22AC101 **HERITAGE OF TAMIL**

L	T	P	C
1	0	0	1

Pre-requisite Nil **Syllabus Version** V 0.1

Course Content:

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 3 Hours

Language Families in India - Dravidian Languages – Tamil as aClassical 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 II NARRATION AND SUMMATION 3 Hours

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 III DESCRIPTION OF A PROCESS / PRODUCT 3 Hours

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

UNIT IV CLASSIFICATION ND RECOMMENDATIONS 3 Hours

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 V EXPRESSION 3 Hours

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 LECTURE HOURS 15 Hours

Text cum Reference Book(s):

1. தமிழக வரலொறு – மக்களும் பண் பொடும் – கக.கக. பிள்ளள (தவளியீடு: தமிழ்நொடு பொடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முளனவர்இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – ளவளக நதிக்களரயில் சங்ககொல நகர நொகரிகம் (ததொல்லியல் துளற தவளியீடு)
4. தபொருளந – ஆற்றங்களர நொகரிகம். (ததொல்லியல் துளற

தவளியீடு)

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 C ivilization on the banks of river Vaigai' (Jointly Published by: 38 Department ofArchaeology & 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) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

22EEC101	APTITUDE AND SOFT SKILLS	L	T	P	C
		1	0	0	1

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To enhance students' cognitive prowess and mental potential.
2. To improve students' mental aptitude relevant to their academic choices, vocational preferences, job profiles and their ability to succeed.
3. To measure a range of skills such as language comprehension, logical thinking and numerical ability.
4. To get familiar with the method of solving aptitude and multi-choice questions.

Course Content:

UNIT I FUNDAMENTALS OF APTITUDE 2 Hours

English diagnostic test - EDT - Logical Reasoning-Puzzles - Factors influencing positive mind set- Importance of self-confidence and self-esteem.

UNIT II SPEAKING SKILLS 3 Hours

Effective communication – Barriers & Strategies – Day to Day conversation -Improving responding capacity – Extempore speech practice – Speech assessment. Arithmetic aptitude – Simplification.

UNIT III READING SKILLS 2 Hours

Reading editorials and opinion blogs-skimming and scamming methods -speed reading. Logical Reasoning-verbal analogies.

UNIT IV GREETINGS 2 Hours

Greetings and expressions- expressing gratitude and apologies -*expressions* of courtesy. Arithmetic aptitude – Percentages.

UNIT V ETIQUETTE 3 Hours

Etiquette- Respect, Consideration & Honesty-oral presentation-role of audio/video visual aids. Logical Reasoning – Non-verbal - Arithmetic aptitude – Introduction to numbers.

TOTAL LECTURE HOURS 12 Hours

Text Book(s):

1. English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press pvt,Ltd.
2. New International Business English by Leo Jones and Richard Alexander. Cambridge University Press pvt,Ltd.
3. Quantitative Aptitude for Competitive Examinations by R S Aggarwal, S. CHAND Publishers.
4. A Modern Approach To Logical Reasoning by R S Aggarwal, S. CHAND Publishers.

22ME101	ENGINEERING MECHANICS - I	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the various system of forces and equilibrium concepts.
2. To understand the concepts of free body diagram, moment and couple system.
3. To make the students to understand the basic properties of solids and hollow sections.
4. To understand the friction effect on rigid bodies.

Expected Course Outcome:

1. Understand the force systems and resultant forces in structures using law of motions.
2. Apply the concept of statics to determine the unknown reactions in 2D.
3. Analyze the reactions in different supports.
4. Calculation of center of gravity and moment of inertia for solids and hollow sections.
5. Determine the friction and the effects by the laws of friction.

Course Content:

UNIT I INTRODUCTION TO ENGINEERING MECHANICS 9 Hours

Introduction-- Units and dimensions - Laws of mechanics- Lame's theorem, Parallelogram and triangular Law of forces- Vectors - Vectorial representation of forces -Coplanar forces - Resolution and composition of forces- Equilibrium of a particle – Free body diagrams.

UNIT II EQUILIBRIUM OF RIGID BODIES 9 Hours

Moments and couples- Vectorial representation of moments and couples - Scalar components of a moment - Varignon's theorem - Resolution of a given force into a force acting at a given point and a couple - Reduction of a system of coplanar forces acting on a rigid body into a single force and a single couple - Equilibrium of rigid bodies in two dimensions.

UNIT III REACTIONS AND SUPPORTS 9 Hours

Types of supports-Types of loads- Supports reactions of beams-Method of finding support reactions of a beam and plane trusses- Method of joints.

UNIT IV CENTRE OF GRAVITY AND MOMENT OF INERTIA 9 Hours

Determination of areas and volumes - First moment of area and the determination of centroid of all cross section - Moment of inertia of plane areas - Parallel axis theorem - Polar moment of inertia-Product of inertia-Principal moments of inertia of plane areas- Radius of Gyration.

UNIT V FRICTION 9 Hours

Types of friction, Limiting friction, Laws of friction – Static and Dynamic Friction; simple contact friction, ladder friction – wedge friction.

TOTAL LECTURE HOURS 45 Hours

Text Book(s):

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, SanjeevSanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11thEdition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.
3. Dhiman A.K, Dhiman P, Kulshreshtha D.C, Engineering Mechanics-Statics and Dynamics, McGraw Hill Education, 2017.

Reference Books:

1. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics- Statics and Dynamics", Vikas Publishing House Pvt.Ltd.New Delhi ,2012.
2. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
3. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
4. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
5. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.

Web Links:

1. e-Krishi Shiksha - Course: Engineering Mechanics (iasri.res.in)
2. Coursera - Introduction to Engineering Mechanics | Coursera
3. Udemy - Engineering Mechanics for 1st Year Engineering Students | Udemy

22ME102	ENGINEERING GRAPHICS	L	T	P	C
		2	2	0	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To develop students in drawing skills for effective communication of concepts, ideas and design of engineering products.
2. To expose students with existing national standards related to technical drawings.

Expected Course Outcome:

1. To Familiarize with the fundamentals and standards of engineering graphics with basic geometrical constructions.
2. To Draw projections of points, lines and plane surfaces.
3. To Draw projections of solids with plane surfaces.
4. To Draw projections and visualize the sectioned solids.
5. To Visualize the developed surfaces.

Course Content:

UNIT I PLANE CURVES 12 Hours

Basic Geometrical constructions, 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 II PROJECTION OF POINTS, LINES AND PLANE SURFACE 12 Hours

Principal Planes-First angle projection-projection of points. 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 traces Projection of planes (Basics).

UNIT III PROJECTION OF SOLIDS 12 Hours

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS 12 Hours

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

UNIT V DEVELOPMENT OF SURFACES AND ISOMETRIC 12 Hours

Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.

TOTAL LECTURE HOURS 60 Hours

Text Book(s):

1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Reference Books:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern EconomyEdition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Web Links:

1. https://www.slideshare.net/ganesasmoorthyraju/unit-1-plane-curves-engineering-graphics
2. https://www.slideshare.net/jayanshugundaniya9/engineering-graphics-projection-of-points-and-lines
3. https://ktuengineeringgraphics.wordpress.com/projections-of-solids
4. https://www.brainkart.com/article/Projection-of-Solids-and-Section-of-Solids_6520
5. https://www.studocu.com/in/document/srm-institute-of-science-and-technology/engineering-graphics-and-design/development-of-surfaces-and-isometric-projection/25573774

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to End Semester Examinations on Engineering Graphics

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day.

22CH101 **ENGINEERING CHEMISTRY**

L	T	P	C
3	0	2	4

Course Objectives:

1. To inculcate sound understanding of water softening methods and desalination techniques.
2. To make the students conversant with basics of polymer chemistry.
3. To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems.
4. To facilitate the understanding of different types of fuels, their preparation, properties.
5. To familiarize the students with the operating principles, working processes and applications of energy Conversion and storage devices.
6. To induce the students to familiarize with electroanalytical techniques such as, potentiometer and conductometry in the determination of impurities in aqueous solutions.

Course Content:

UNIT I WATER TECHNOLOGY 9

Hardness of water- types - disadvantages of using hard water in industries – estimation of total, permanent and temporary hardness of water by EDTA method -Boiler troubles (scale and sludge)- Boiler feed water treatment – external conditioning - demineralization process - desalination by reverse osmosis – potable water treatment - breakpoint of chlorination.

UNIT II POLYMER AND COMPOSITES 9

Polymer: types – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Bakelite.
Composites: definition, types of composites – polymer matrix composites (PMC)– fibre reinforced plastics (FRP) - applications.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel.

Phase rule: definition of terms with examples, one component system -water system – reduced phase rule – two component systems – lead-silver system –Pattinson process, Cu-Ni system.

UNIT IV ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission – controlled nuclear fission – nuclear fusion – nuclear chain reactions – nuclear energy – light water nuclear power plant – breeder reactor – solar energy conversion – solar cells – wind energy.
Batteries, fuel cells and super capacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell- super capacitors.

UNIT V FUELS AND COMBUSTION 9

Fuels: Classification of fuels – coal – proximate and ultimate analysis – carbonization – manufacture of metallurgical coke (Otto Hoffmann method) – petroleum – refining – manufacture of synthetic petrol (Bergius process) – knocking – octane number – diesel oil – cetane number – compressed natural gas (CNG) – liquefied petroleum gases (LPG) – power alcohol and biodiesel.

Combustion of fuels: Calorific values – calculations – theoretical air requirement – ignition temperature – spontaneous ignition temperature– flue gas analysis (chromatography and gas sensors).

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. To analyse the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
2. Discuss the types of polymer formation and composites.
3. To apply the knowledge of phase rule and alloys for material selection requirements.
4. To recommend suitable fuels for engineering processes and applications.
5. To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
6. To quantitatively analyse the impurities in solution by electro analytical techniques.

Text Book(s):

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.

Reference Books:

1. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
2. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
3. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
4. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.

List of Experiments:

1.	Determination of total, temporary & permanent hardness of water by EDTA method.	**3**
2.	Determination of chloride content of water sample by Argentometric method.	**3**
3.	Estimation of copper content of the given solution by Iodometry.	**3**
4.	Determination of alkalinity in water sample.	**3**
5.	Determination of DO content of water sample by Winkler's Method.	**3**
6.	Estimation of Phase change in a solid.	**3**
7.	Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.	**3**
8.	Determine strength of given hydrochloric acid using pH meter.	**3**

9.	Determine strength of acids in a mixture of acids using conductivity meter.	**3**
10.	Determine iron content of the given solution using potentiometer.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

22CS201	**PROBLEM SOLVING TECHNIQES - II**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the constructs of C Language.
2. To develop C Programs using basic programming constructs
3. To develop C programs using arrays and strings
4. To develop modular applications in C using functions
5. To develop applications in C using pointers and structures
6. To do input/output and file handling in C

Course Content:

UNIT I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms – Applications of C Language - Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision making statements - Switch statement - Looping statements – Preprocessor directives - Compilation process.

UNIT II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binary search.

UNIT III FUNCTIONS AND POINTERS 9

Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – Recursion, Binary Search using recursive functions –Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference.

UNIT IV STRUCTURES AND UNION 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union - Storage classes and Visibility.

UNIT V FILE PROCESSING 9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Demonstrate knowledge on C Programming constructs
2. Develop simple applications in C using basic constructs
3. Design and implement applications using arrays and strings
4. Develop and implement modular applications in C using functions.
5. Develop applications in C using structures and pointers.
6. Design applications using sequential and random access file processing.

Text Book(s):

1. ReemaThareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.

Reference Books:

1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.

List of Experiments:

1.	Write a C program to calculate and display the area of a rectangle using the input values entered by the user.	**3**
2.	Write a C program to sort an array of integers using selection sort technique.	**3**
3.	Write a C program to concatenate two strings entered by the user and display the resultant string.	**3**
4.	Write a C program to find the factorial of a number using recursion.	**3**
5.	Write a C program to swap two numbers using call by value and call by reference.	**3**
6.	Write a C program to create a structure named student with the fields roll no, name, and marks in three subjects. Initialize the structure with the values entered by the user and display the details.	**3**
7.	Write a C program to read data from a text file and display it on the screen.	**3**
8.	Write a C program to implement a singly linked list and display its elements.	**3**
9.	Write a C program to open a binary file, write data to it, and read data from it.	**3**
10.	Write a C program to implement a stack using an array and perform push, pop, and display operations.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipment: (for batch of 30 students)

1.	Standalone Computer	30 nos
2.	TURBO C	-

22HS201	TECHNICAL ENGLISH	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

The Course prepares second semester engineering and Technology students to:

1. Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
2. Foster their ability to write convincing job applications and effective reports.
3. Develop their speaking skills to make technical presentations, participate in group discussions.
4. Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialisation.

Course Content:

UNIT I INTRODUCTION TECHNICAL ENGLISH 9

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises. Speaking –Asking for and giving directions- Reading – reading short technical texts from journals- newspapers. Writing- purpose statements – extended definitions – issue-writing instructions – checklists-recommendations.

UNIT II READING AND STUDY SKILLS 9

Listening- Listening to longer technical talks and completing exercises based on them-Speaking – describing a process-Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing- Writing-interpreting charts, graphs.

UNIT III TECHNICAL WRITING AND GRAMMAR 9

Listening- Listening to classroom lectures/ talks on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words.

UNIT IV REPORT WRITING 9

Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations- Reading – reading for detailed comprehension- Writing- email etiquette- job application – cover letter –Résumé preparation (via email and hard copy)- analytical essays and issue based essays.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 9

Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey- Vocabulary Development verbal analogies Language Development- reported speech.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

Upon successful completion of the course, students should be able to:

1. At the end of the course learners will be able to:
2. Read technical texts and write area- specific texts effortlessly.
3. Listen and comprehend lectures and talks in their area of specialisation successfully.
4. Speak appropriately and effectively in varied formal and informal contexts.
5. Write reports and winning job applications.

Text Book(s):

1. Board of editors. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016

Reference Books:

1. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges. Cengage Learning, USA: 2007
5. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi,2014. Students can be asked to read Tagore, Chetan Bhagat and for suplementary reading.

22MA201	**NUMERICAL METHODS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the basic concepts of solving algebraic and transcendental equations.
2. To introduce the numerical techniques of interpolation in various intervals in real life situations.
3. To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
4. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
5. To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

Course Content:

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - Fixed point iteration method– Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi’s method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals - Lagrange's interpolation – Newton’s divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton’s forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson’s 1/3 rule – Romberg’s Method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson’s 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference methods for solving second order two - point linear boundary value problems - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

Upon successful completion of the course, students should be able to:

1. Understand the basic concepts and techniques of solving algebraic and transcendental equations.
2. Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
3. Apply the numerical techniques of differentiation and integration for engineering problems.
4. Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
5. Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

Text Book(s):

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

Reference Books:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia,6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5thEdition, 2015.

22HS202	ENVIRONMENTAL SCIENCE	L	T	P	C
		2	0	0	2

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To gain the knowledge about environment, ecological balance and biodiversity.
2. To finding and implementing scientific, technological, economic and political solutions to
   environmental problems.
3. To study the interrelationship between living organism and environment.
4. To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
5. To study the dynamic processes and understand the features of the earth's interior and surface.
6. To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Course Content:

UNIT I ENVIRONMENT, ECOSYSTEMS & BIODIVERSITY 6

Definition, scope and importance of environment – ecosystem – energy flow in the ecosystem – food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) desert ecosystem. Biodiversity – definition, types, value of biodiversity (consumptive use, productive use, social, ethical, aesthetic and option values) – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts –conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT II ENVIRONMENTAL POLLUTION 6

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Noise pollution (d) Nuclear hazards. Solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution.

UNIT III NATURAL RESOURCES 6

Forest resources: Use and over-exploitation, deforestation – Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems – Mineral resources: environmental effects of extracting and using mineral resources – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity – Energy resources: renewable – solar, wind, biomass and non-renewable energy sources-coal and nuclear energy.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 6

Sustainable development – urban problems related to energy, consumerism and waste products –
water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns – role of non-governmental organization - environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion - wasteland reclamation - 12 principles of green chemistry.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health.

TOTAL LECTURE PERIODS 30 Periods

Expected Course Outcome:

Upon successful completion of the course, students should be able to:

1. Interfere the importance of environment and explain the concept, structure, functions of ecosystem and summarize different values, threats and the need for conservation of biodiversity.
2. Explain the types of natural resources and its importance of conservation.
3. Classify the types of pollution and propose suitable methods to prevent pollution.
4. Outline the various social issues and possible solutions to protect environment for sustainable Development.
5. Describe the effect of population explosion, trend of population in various countries and understand the role of IT in environment and human health.

Text Book(s):

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi,2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education,2004.

Reference Books:

1. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT LTD, New Delhi,2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press,2005.

22AC201	**TAMILS AND TECHNOLOGY**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Content:

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II 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 III 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 IV 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 V 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 LECTURE PERIODS 15 Periods

Text cum Reference Books:

1. தமிழக வரலொறு – மக்களும் பண் பொடும் – மக.மக. பிள்மள (தவளியீடு: தமிழ்நொடு பொடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2. கணினித் தமிழ் – முமனவர ்இல. சுந்தரம் . (விகடன் பிரசுரம்).

3. கீழடி – மவமக நதிக்கமரயில் ெங்ககொல நகர நொகரிகம் (ததொல்லியல் துமற தவளியீடு)

4. தபொருமந – ஆற்றங்கமர நொகரிகம். (ததொல்லியல் துமற தவளியீடு)

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 C ivilization 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.

22EEC201	APTITUDE AND SOFT SKILLS II	L	T	P	C
		1	0	0	1

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

- To enhance Cognitive Abilities Improving critical thinking, problem-solving and decision-making skills to achieve better academic and professional outcomes.
- Boosting Soft Skills and Developing interpersonal, communication and time-management skills to excel in personal and professional relationships.
- Enhancing verbal and written communication skills to promote effective collaboration and build relationships.
- Developing self-awareness, empathy, and social skills to navigate complex interpersonal situations and increase team morale.

Course Content:

UNIT I APTITUDE 3

Personality Assessment - SWOT analysis - Adaptability and Flexibility - Team building activity - Numerical Reasoning - calculations, identify patterns, and problem solving.

UNIT II SPEAKING SKILLS 3

Core Components of Effective Communication - Non-Verbal Communication - active listening and written communication - Business English - Communication enhancement activities - Abstract Reasoning - shapes, symbols, or images - Visual Reasoning.

UNIT III READING SKILLS 3

Vocabulary Building – Comprehension – Fluency - Critical Reading - Reading for Information - Group problem-solving activities - Critical thinking and analysis - Creative problem solving - Decision making and evaluation - Deductive reasoning and connectives - Logical puzzles and games.

UNIT IV FLOW STATE 3

S.M.A.R.T Goal Setting - Developing action plans - Overcoming Obstacles - Review and Reflection - Habit Building - Identifying Habits - Maintaining Habits - Habit Stacking Arithmetic aptitude - Number system.

UNIT V EMOTIONAL QUOTIENT 3

Emotional Intelligence - Empathy and interpersonal skills - Self-awareness and self-regulation - Motivation and drive - Social awareness and relationship management - Quantitative aptitude - Equations - Word problems.

TOTAL LECTURE PERIODS 15 Periods

Expected Course Outcome:

- Increased efficiency, productivity and performance in academic and professional settings.
- Enhanced communication, collaboration and teamwork among students.

- Increased ability to identify, analyze and solve complex problems in personal and professional settings.
- Improved self-awareness, emotional intelligence and interpersonal skills leading to better personal and professional relationships.

Text Book(s):

- Quantitative Aptitude for Competitive Examinations - 2022/edition-S Chand Publishing-Paperback_Edition-2022.
- Fast Track Objective Arithmetic by Rajesh Verma, January 2018 edition.
- How to Talk to Anyone: 92 Little Tricks for Big Success in Relationships, Publisher: Harper Element; New edition.
- Emotional Intelligence by Daniel Goleman, Bloomsbury Publishing India Private Limited; new edition, January 1995.

Reference Books:

- How to Prepare for Quantitative Aptitude for CAT by Arun Sharma, McGraw Hill Education; Eighth edition.
- The Pearson Guide to Quantitative Aptitude for Competitive Examinations by Dinesh Khattar
- Crucial Conversations by Al Switzler, Joseph Grenny, and Ron McMillan, Brilliance Audio; Abridged, Updated edition, August 2013.
- Nonviolent Communication by Marshall B. Rosenberg, Puddle Dancer Press; 3rd edition, September 2015.

22EE102	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the basics of electric circuits and analysis
2. To impart knowledge in the basics of working principles and application of electrical machines
3. To introduce analog devices and their characteristics
4. To educate on the fundamental concepts of digital electronics
5. To introduce the functional elements and working of measuring instruments

Course Content:

UNIT I ELECTRICAL CIRCUITS 9

Introduction to DC Circuits - Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws - Nodal Analysis, Mesh analysis with Independent sources only (Steady state) - Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, real power, reactive power and apparent power, power factor.

UNIT II ELECTRICAL MACHINES 9

Construction and Working principle- DC Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, working principle and Applications of Transformer, Three Phase Induction Motor.

UNIT III ANALOG ELECTRONICS 9

Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, UJT, MOSFET, DIAC, TRIAC – Types, V-I Characteristics and Applications, Rectifiers.

UNIT IV DIGITAL ELECTRONICS 9

Number systems (Binary, Gray, Decimal and Hexa-decimal), Code Converters (Binary to Gray, Gray to Binary, BCD to Excess-3, Excess-3 to BCD) - Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps-Flip Flop.

UNIT V MEASUREMENTS AND INSTRUMENTATION 9

Functional elements of an instrument, Standards and calibration, Operating Principle, types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT, DSO- Block diagram.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. Compute the electric circuit parameters for simple problems
2. Explain the working principle and applications of electrical machines
3. Analyze the characteristics of analog electronic devices
4. Explain the basic concepts of digital electronics
5. Explain the operating principles of measuring instruments

Text Book(s):

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.
3. James A. Svoboda, Richard C. Dorf, “Dorf’s Introduction to Electric Circuits”, Wiley, 2018.
4. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.

Reference Books:

1. Kothari DP and I.J Nagrath, “Basic Electrical Engineering”, Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, ‘Digital Fundamentals’, 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, ‘Electronic Principles, McGraw Hill Education; 9th edition,2021.
4. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, 7th Edition, 2018.
5. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010

22ES201 **ENGINEERING PRACTICES LABORATORY**

L	T	P	C
0	0	2	1

Pre-requisite **Syllabus Version** V 0.1

GROUP A (CIVIL &MECHANICAL)

List of Experiments: (Civil Engineering)

PLUMBING WORK

1 Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2 Preparing plumbing line sketches.
3 Laying pipe connection to the suction side of a pump
4 Laying pipe connection to the delivery side of a pump.
5 Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances

WOOD WORK:

1 Sawing
2 Planing and
3 Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.
4 Studying joints in door panels and wooden furniture
5 Studying common industrial trusses using models.

WELDING WORK:

1 Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
2 Practicing gas welding.

BASIC MACHINING WORK:

1 (simple)Turning.
2 (simple)Drilling.
3 (simple)Tapping.

ASSEMBLY WORK:

1 Assembling a centrifugal pump.
2 Assembling a household mixer.
3 Assembling an airconditioner.

SHEET METAL WORK:

1 Making of a square tray

FOUNDRY WORK:

1 Demonstrating basic foundry operations.

GROUP B (ELECTRICAL AND ELECTRONICS)

ELECTRICAL ENGINEERING PRACTICES

1 Introduction to switches, fuses, indicators and lamps - Basic switch boardwiring with lamp, fan and three pin socket
2 Staircase wiring
3 Fluorescent Lamp wiring with introduction to CFL and LED types.
4 Energy meter wiring and related calculations/ calibration
5 Study of Iron Box wiring and assembly
6 Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
7 Study of emergency lamp wiring/Water heater

ELECTRONIC ENGINEERING PRACTICES

SOLDERING WORK:

1 Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

1 Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

1 Study an elements of smart phone.
2 Assembly and dismantle of LED TV.
3 Assembly and dismantle of computer/ laptop

TOTAL PRACTICAL PERIODS **30 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1.Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

2.Wire various electrical joints in common household electrical wire work.

3.Weld various joints in steel plates using arc welding work; Machine various simple processeslike turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

4.Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

Reference Books:

1. S Gowri & T Jeyapoovan, Engineering Practices Lab Manual, Vikas Publishing-2021.

List of Equipment: (For A Batch of 30 Students)

1.CIVIL ENGINEERING

1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	**15 Sets.**
2.	Carpentry vice (fitted to work bench)	**15 Nos.**
3.	Standard woodworking tools	**15 Sets.**
4.	Models of industrial trusses, door joints, furniture joints	**5 Each.**
5.	Rotary Hammer	**2 Nos.**
6.	Demolition Hammer	**2 Nos.**
7.	Circular Saw	**2 Nos.**
8.	Planer	**2 Nos.**
9.	Hand Drilling Machine	**2 Nos.**
10.	Jigsaw	**2 Nos.**

2.MECHANICAL

1.	Arc welding transformer with cables and holders	**5 Nos.**
2.	Welding booth with exhaust facility	**5 Nos.**
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	**5 Sets.**
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	**2 Nos.**
5.	Centre lathe	**2 Nos.**
6.	Hearth furnace, anvil and smithy tools	**2 Sets.**
7.	Moulding table, foundry tools	**2 Sets.**
8.	Power Tool: Angle Grinder	**2 Nos**

9.	Study-purpose items: centrifugal pump, air-conditioner	**One each**

3.ELECTRICAL

1.	Assorted electrical components for house wiring	**15 Sets.**
2.	Electrical measuring instruments	**10 Sets.**
3.	Study purpose items: Iron box, fan and regulator, emergency lamp	**1 Each.**
4.	Megger (250V/500V)	**1 No.**
5.	Range Finder	**2 Nos.**
6.	Digital Live-wire detector	**2 Nos.**

4.ELECTRONICS

1.	Soldering guns	**10 Nos.**
2.	Assorted electronic components for making circuits	**50 Nos.**
3.	Small PCBs	**10 Nos.**
4.	Multimeters	**10 Nos.**
5.	Study purpose items: Telephone, FM radio, low-voltage power supply	**1 Each.**

22CS302	PROBLEM SOLVING TECHNIQUE-III	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand Object Oriented Programming concepts and basics of Java programming language
2. To know the principles of packages, inheritance and interfaces
3. To develop a java application with threads and generics classes
4. To define exceptions and use I/O streams
5. To design and build Graphical User Interface Application using JAVAFX.

Course Content:

UNIT I INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors- Methods -Access specifiers - Static members- Java Doc comments.

UNIT II INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.

UNIT III EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model– Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT IV I/O, GENERICS, STRING HANDLING 9

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

UNIT V JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu Menu bars – MenuItem

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply the concepts of classes and objects to solve simple problems.
2. Develop programs using inheritance, packages and interfaces.
3. Make use of exception handling mechanisms and multithreaded model to solve real world problems.
4. Build Java applications with I/O packages, string classes, Collections and generics. concepts Integrate the concepts of event handling and JavaFX components and controls for developing GUIbased applications.

Text Book(s):

1. Herbert Schildt, "Java: The Complete Reference", 11 th Edition, McGraw Hill Education, New Delhi,2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1 st Edition, McGraw Hill Education, NewDelhi, 2015

Reference Books:

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11 th Edition, Prentice Hall, 2018.

List of Experiments:

1.	Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion).	**3**
2.	Develop stack and queue data structures using classes and objects.	**3**
3.	Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id,Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their grossand net salary.	**3**
4.	Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.	**3**
5.	Solve the above problem using an interface	**3**
6.	Implement exception handling and creation of user defined exceptions	**3**
7.	Write a java program that implements a multi-threaded application that has three threads. Firstthread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print thevalue of the cube of the number.	**3**
8.	Write a program to perform file operations.	**3**
9.	Develop applications using JavaFX controls, layouts and menus	**3**
10.	Develop a mini project for any application using Java concepts.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1. Operating Systems: Linux / Windows 30 nos
2. Front End Tools: Eclipse IDE / Netbeans IDE -

22ME301	STRENGTH OF MATERIALS	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the concepts of stress, strain, principal stresses and principal planes.
2. To study the concept of shearing force and bending moment due to external loads in Determinate beams and their effect on stresses.
3. To determine stresses and deformation in circular shafts and helical spring due to torsion.
4. To compute slopes and deflections in determinate beams by various methods.
5. To study the stresses and deformations induced in thin and thick shells.

Course Content:

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses - Deformation of simple and compound bars – Thermal stresses – Elastic constants - Volumertric strains – Stresses on inclined planes – Principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – Types - Transverse loading on beams – Shear force and Bending moment in beams – Cantilever, Simply supported and over hanging beams. Theory of simple bending – Bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Theory of Torsion – Stresses and Deformations in Solid and Hollow Circular Shafts – Combined bending moment and torsion of shafts - Power transmitted to shaft – Shaft in series and parallel – Closed and Open Coiled helical springs – springs in series and parallel.

UNIT IV DEFLECTION OF BEAMS 9

Elastic curve – Governing differential equation - Double integration method - Macaulay's method - Area moment method - Conjugate beam method for computation of slope and deflection of determinant beams

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure - circumferential and longitudinal stresses - Deformation in thin cylinders – Spherical shells subjected to internal pressure – Deformation in spherical shells – Thick cylinders - Lame's theory.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the properties and behavior in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps.

Text Book(s):

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th edition, 2018.
2. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt .Ltd., New Delhi, 2017.

Reference Books:

1. Singh. D.K., "Strength of Materials", Ane Books Pvt Ltd., New Delhi, 2021.
2. Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.
3. Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi 2019.
4. Vazirani. V.N, Ratwani. M.M, Duggal .S.K "Analysis of Structures: Analysis, Design and Detailing of Structures-Vol.1", Khanna Publishers, New Delhi 2014.

List of Experiments:

1.	Tension test on mild steel rod	**3**
2.	Torsion test on mild steel rod	**3**
3.	Double shear test on Mild steel and Aluminium rods	**3**
4.	Impact test on metal specimen	**3**
5.	Hardness test on metals - Brinnell and Rockwell Hardness Number	**3**
6.	Deflection test on Beams	**3**
7.	Compression test on helical springs	**4**
8.	Effect of hardening- Improvement in hardness and impact resistance of steel	**4**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	Universal Tensile Testing machine with double 1 shear attachment –40 Ton Capacity	1 no
2.	Torsion Testing Machine (60 NM Capacity)	1 no
3.	Impact Testing Machine (300 J Capacity)	1 no
4.	Brinell Hardness Testing Machine	1 no
5.	Rockwell Hardness Testing Machine	1 no
6.	Spring Testing Machine for tensile and compressive loads (2500 N)	1 no

22ME302	**THEORY OF MACHINES**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To study the basic components of mechanisms, analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism and design cammechanisms for specified output motions.

2.To study the basic concepts of toothed gearing and kinematics of gear trains.

3. To Analyzing the effects of friction in machine elements

4. To Analyzing the force-motion relationship in components subjected to external forces and analyzing of standard mechanisms.

5. To Analyzing the undesirable effects of unbalances resulting from prescribed motions in mechanismand the effect of dynamics of undesirable vibrations.

Course Content:

UNIT I KINEMATICS OF MECHANISMS 9

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematicsanalysis in simple mechanisms– cams – classifications – displacement diagrams - layout of plate cam profiles.

UNIT II GEARS AND GEAR TRAINS 9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interferenceand undercutting — nonstandard teeth — gear trains — parallel axis gears trains — epicyclic gear trains —automotive transmission gear trains.

UNIT III FRICTION IN MACHINE ELEMENTS 9

Surface contacts – Sliding and Rolling friction – Bearings and lubrication – Friction clutches - single plate clutch -multi plate clutch – Belt drives -flat belt drive.

UNIT IV FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Three and four members – Static Force analysis in simple machine members – Dynamic Force Analysis – Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle.

UNIT V BALANCING AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines –free

vibrations–longitudinal and transverse vibrations-Equations of motion – natural Frequency – Damped Vibration –Forced vibration.

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: At the end of the course the students would be able to

1. Discuss the basics of mechanism.
2. Solve problems on gears and gear trains.
3. Examine friction in machine elements.
4. Calculate static and dynamic forces of mechanisms.
5. Calculate the balancing masses and their locations of reciprocating and rotating masses. Computing the frequency of free vibration, forced vibration and damping coefficient

Text Book(s):

1.Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford UniversityPress, 2017.
2.Ramamurthi. V, "Mechanics of Machines", Narosa Publishing House, 3rd edition 2019.

Reference Books:

1.AmitabhaGhosh and Asok Kumar Mallik, "Theory of Mechanisms and Machines", Affiliated East-WestPvt. Ltd., 1988.
2.Rao.J.S. and Dukkipati.R.V. "Mechanism and Machine Theory", New Age International Pvt. Ltd., 2ndedition,2014.
3.Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 5th edition 2019.
4.Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2013.
5.Wilson and Sadler, Kinematics and Dynamics of Machinery, Pearson, 2008.

List of Experiments:

1. Transverse vibrations simply supported beam
2. Transverse vibrations -cantilever beam
3. To determine natural frequency of torsional vibration in two rotors system
4. Motorized gyroscope – Study of gyroscopic effect and couple
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. Single degree of freedom Spring Mass System
8. Balancing of rotating masses.
9. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads
10. Vibration of Equivalent Spring mass system – un damped and damped vibration.

TOTAL PRACTICAL PERIODS **30 Periods**

TOTAL LECTURE CUM PRACTICAL PERIODS **75 Periods**

List of Equipments: (for batch of 30 students)

1.	Cam follower setup.	1 nos
2.	Motorised gyroscope.	1 nos
3.	Governor apparatus - Watt, Porter, Proell and Hartnell governors.	1 nos
4.	Whirling of shaft apparatus.	1 nos
5.	Dynamic balancing machine.	1 nos
6.	Two rotor vibration setup.	1 nos
7.	Spring mass vibration system.	1 nos
8.	Torsional Vibration of single rotor system setup.	1 nos
9.	Simply supported beam setup	1 nos
10	Cantilever beam setup	1 nos

22AG302	**FLUID MECHANICS AND MACHINERY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the students about properties of the fluids, behaviour of fluids under static conditions.
2. To impart basic knowledge of the dynamics of fluids and boundary layer concept.
3. To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on pipe bends.
4. To exposure to the significance of boundary layer theory and its thicknesses.
5. To expose the students to basic principles of working of hydraulic machineries and to design Pelton wheel, Francis and Kaplan turbine, centrifugal and reciprocating pumps.

Course Content:

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Properties of fluids – Fluid statics - Pressure Measurements - Buoyancy and floatation - Flow characteristics - Eulerian and Lagrangian approach - Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation - Applications.

UNIT II FLOW THROUGH PIPES AND BOUNDARY LAYER 9

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9

Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV TURBINES 9

Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.

UNIT V PUMPS 9

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it's variations - Work saved by fitting air vessels - Rotary pumps.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics
2. Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.
3. Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies
4. Explain the working principles of various turbines and design the various types of turbines.
5. Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

Text Book(s):

1. Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.

Reference Books:

1. Fox W.R. and McDonald A.T., Introduction to Fluid Mechanics John-Wiley and Sons, Singapore, 2011.
2. Pani B S, Fluid Mechanics: A Concise Introduction, Prentice Hall of India Private Ltd, 2016.
3. Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014
4. S K Som, Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.

List of Experiments:

1.	Determination of the Coefficient of discharge of given Orifice mete.	**4**
2.	Determination of the Coefficient of discharge of given Venturi meter.	**4**
3.	Calculation of the rate of flow using Rota meter.	**3**
4.	Determination of friction factor for a given set of pipes.	**3**
5.	Conducting experiments and drawing the characteristic curves of	**4**

centrifugal pump

6. Conducting experiments and drawing the characteristic curves of submergible pump **4**
7. Conducting experiments and drawing the characteristic curves of reciprocating pump. **4**
8. Conducting experiments and drawing the characteristic curves of Pelton wheel. **4**

TOTAL PRACTICAL PERIODS 30 Periods
TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1. Orifice meter setup 1 no
2. Venturimeter setup 1 no
3. Rotameter setup 1 no
4. Pipe Flow analysis setup 1 no
5. Centrifugal pump/submergible pump 1 no
6. Reciprocation pump set up 1 no
7. Pelton Wheel turbine set up 1 no
8. Stop watch 10 nos
9. Tachometer 1 no

22MA301	**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the basic concepts of PDE for solving standard partial differential equations.
2. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4. To acquaint the student with Fourier, transform techniques used in wide variety of situations.
5. To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

Course Content:

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations - Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types- Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation – One dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 9+3

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

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand how to solve the given standard partial differential equations.
2. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
3. Appreciate the physical significance of Fourier series techniques in solving one- and two- dimensional heat flow problems and one-dimensional wave equations.
4. Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
5. Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems

Text Book(s):

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt. Ltd.1998.

Reference Books:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata Mc Graw Hill Publishing Company Limited, NewDelhi, 2008.
3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.

4. Erwin Kreyszig, “Advanced Engineering Mathematics”, 8th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, “Advanced Engineering Mathematics” Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Datta.K.B., “Mathematical Methods of Science and Engineering”, Cengage Learning India Pvt Ltd, Delhi, 2013.

22ME303	**MANUFACTURING PROCESSES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To illustrate the working principles of various metal casting processes.
2. To learn and apply the working principles of various metal joining processes.
3. To analyse the working principles of bulk deformation of metals.
4. To learn the working principles of sheet metal forming process.
5. To study and practice the working principles of plastics molding.

Course Content:

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting –- Defects in Sand casting process- remedies.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Oxy fuel welding – Filler and Flux materials-–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electroslag welding– Plasma arc welding –– Resistance welding Processes -Electron beam welding –Laser beamWelding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging –cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wiredrawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shapingoperations.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical 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 – Incremental forming.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff molding.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the principle of different metal casting processes.
2. Describe the various metal joining processes.
3. Illustrate the different bulk deformation processes.
4. Apply the various sheet metal forming process.
5. Apply suitable molding technique for manufacturing of plastics components.

Text Book(s):

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India,4th Edition, 2013
2. P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition,2018..

Reference Books:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. S. Gowri P. Hariharan, A.Suresh Babu, Manufacturing Technology I, Pearson Education, 2008.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eligth Edition, Materials and Processes, in Manufacturing, Eight Edition, Prentice – Hall of India, 1997.
4. Hajra Chouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997
5. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004

22ME401	MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To study the concepts and basic mechanics of metal cutting and the factors affecting machinability
2. To learn working of basic and advanced turning machines.
3. To teach the basics of machine tools with reciprocating and rotating motions and abrasive finishingprocesses.
4. To study the basic concepts of CNC of machine tools and constructional features of CNC.
5. To learn the basics of CNC programming concepts to develop the part programme for Machinecentre and turning centre

Course Content:

UNIT I MECHANICS OF METAL CUTTING 9

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

UNIT II TURNING MACHINES 9

Centre lathe, constructional features, specification, operations — taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Speciallathes

UNIT III RECIPROCATING MACHINE TOOLS 9

Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation -Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel

UNIT IV CNC MACHINES 9

Computer Numerical Control (CNC) machine tools, constructional details, special features — Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous - Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems,Safety features.

UNIT V PROGRAMMING OF CNC MACHINE TOOLS 9

Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles,

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1. Apply the mechanism of metal removal process and to identify the factors involved in improvingmachinability.
2. Describe the constructional and operational features of centre lathe and other special purposelathes.

3. Describe the constructional and operational features of reciprocating machine tools.
4. Apply the constructional features and working principles of CNC machine tools
5. Demonstrate the Program CNC machine tools through planning, writing codes and setting up CNCmachine tools to manufacture a given component.

Text Book(s):

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education, India, 7th Edition,2018.
2. Michael Fitzpatrick, Machining and CNC Technology, McGraw-Hill Education; 4th edition, 2018.

Reference Books:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 1984.
3. R ao. P.N "Manufacturing Technology," Metal Cutting and Machine Tools, Tata McGraw- Hill, New Delhi,2009.

List of Experiments:

1.	Fabricating simple structural shapes using Gas Metal Arc Welding machine.	**3**
2.	Preparing green sand moulds with cast patterns.	**3**
3.	Taper Turning and Eccentric Turning on circular parts using lathe machine.	**3**
4.	Knurling, external and internal thread cutting on circular parts using lathe machine.	**3**
5.	Shaping – Square and Hexagonal Heads on circular parts using shaper machine.	**3**
6.	Drilling and Reaming using vertical drilling machine.	**3**
7.	Milling contours on plates using vertical milling machine.	**3**
8.	Cutting spur and helical gear using milling machine.	**3**
9.	Generating gears using gear hobbing machine.	**3**
10.	Generating gears using gear shaping machine.	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	Centre Lathes	7 Nos.
2.	Shaper	1 No.
3.	Horizontal Milling Machine	1 No.
4.	Vertical Milling Machine	1 No.
5.	Surface Grinding Machine	1 No.
6.	Cylindrical Grinding Machine	1 No.
7.	Radial Drilling Machine	1 No.
8.	Lathe Tool Dynamometer	1 No.

22MA303	PROBABILITY AND STATISTICS	L	T	P	C
		3	1	0	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. This course aims at providing the required skill to apply the statistical tools in engineering problems.
2. To introduce the basic concepts of probability and random variables.
3. To introduce the basic concepts of two dimensional random variables.
4. To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
5. To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

Course Content:

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Probability – Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 9+3

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 9+3

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

UNIT V STATISTICAL QUALITY CONTROL 9+3

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

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

1. Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
2. Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
3. Apply the concept of testing of hypothesis for small and large samples in real life problems.
4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.

5. Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

Text Book(s):

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

Reference Books:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

22ME402	**ENGINEERING THERMODYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Impart knowledge on the basics and application first law of thermodynamics.
2. Impart knowledge on the second law of thermodynamics and entropy concepts
3. Teach the various properties of steam through steam tables and Mollier chart.
4. Impart knowledge on the macroscopic properties of ideal and real gases.
5. Gain knowledge of psychometric properties and its processes

Course Content:

UNIT I BASICS AND FIRST LAW OF THERMODYNAMICS 9

Review of Basics — Thermodynamic systems, Properties and processes Thermodynamic Equilibrium - Displacement work - P-V diagram. Thermal equilibrium - Zeroth law — Concept of temperature and Temperature Scales. First law — application to closed and open systems — steady and unsteady flow processes.

UNIT II SECOND LAW AND ENTROPY 9

Heat Engine — Refrigerator - Heat pump. Statements of second law and their equivalence & corollaries. Carnotcycle - Reversed Carnot cycle - Performance - Clausius inequality. Concept of entropy - T-s diagram - Tds Equations - Entropy change for a pure substance.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles

UNIT IV GAS MIXTURES AND THERMODYNAMIC RELATIONS 9

Properties of Ideal gas, real gas - comparison. Equations of state for ideal and real gases. vander Waal's relation - Reduced properties - Compressibility factor - Principle of Corresponding states – Generalized Compressibility Chart. Maxwell relations - TdS Equations - heat capacities relations - Energy equation, Joule-Thomson experiment - Clausius-Clapeyron equation.

UNIT V PSYCHROMETRY 9

Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1. Apply the zeroth and first law of thermodynamics by formulating temperature scales and calculating the property changes in closed and open engineering systems.
2. Apply the second law of thermodynamics in analysing the performance of thermal devices through energy and entropy calculations.
3. Apply the second law of thermodynamics in evaluating the various properties of steam through steam tables and Mollier chart
4. Apply the properties of pure substance in computing the macroscopic properties of ideal and real gases using gas laws and appropriate thermodynamic relations.
5. Apply the psychometric properties and its processes

Text Book(s):

1.Nag.P.K., “Engineering Thermodynamics”, 6th Edition, Tata McGraw Hill (2017), New Delhi.
2.Natarajan, E., “Engineering Thermodynamics: Fundamentals and Applications”, 2nd Edition (2014), Anuragam Publications, Chennai.

Reference Books:

1.Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,9th Edition,2019.
2.Chattopadhyay, P, “Engineering Thermodynamics”, 2nd Edition Oxford University Press, 2016.
3.Rathakrishnan, E., “Fundamentals of Engineering Thermodynamics”, 2nd Edition, Prentice Hall of IndiaPvt. Ltd, 2006.
4.Claus Borgnakke and Richard E. Sonntag, “Fundamentals of Thermodynamics”, 10th Edition, WileyEastern, 2019.
5.Venkatesh. A, “Basic Engineering Thermodynamics”, Universities Press (India) Limited, 2007

22ME403	ENGINEERING MATERIALS AND METALLURGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn the constructing the phase diagram and using of iron-iron carbide phase diagram formicrostructure formation.
2. To learn selecting and applying various heat treatment processes and its microstructureformation.
3. To illustrate the different types of ferrous and non-ferrous alloys and their uses in engineering field.
4. To illustrate the different polymer, ceramics and composites and their uses in engineering field.
5. To learn the various testing procedures and failure mechanism in engineering field.

Course Content:

UNIT I CONSTITUTION OF ALLOYS AND PHASE DIAGRAMS 9

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

UNIT II HEAT TREATMENT 9

Definition – Full annealing, stress relief, recrystallisation and spheroidising –normalizing, hardening and tempering of steel. Isothermal transformation diagrams – cooling curves superimposed on I.T. diagram – continuous cooling Transformation (CCT) diagram – Austempering, Martempering – Hardenability,Jominy end quench test -case hardening, carburizing, Nitriding, cyaniding, carbonitriding – Flame and Induction hardening – Vacuum and Plasma hardening – Thermo-mechanical treatments- elementaryideas on sintering.

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel (Mn, Si, Cr, Mo, Ni, V,Ti& W) – stainless and tool steels – HSLA -Maraging steels – Grey, white, malleable, spheroidal – alloy cast irons, Copper and its alloys – Brass, Bronze and Cupronickel – Aluminium and its alloys; Al-Cu – precipitation strengthening treatment – Titanium alloys, Mg-alloys, Ni-based super alloys – shape memory alloys- Properties and Applications-overview of materials standards.

UNIT IV NON-METALLIC MATERIALS 9

Polymers – types of polymers, commodity and engineering polymers – Properties and applications ofPE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PAI, PPO, PPS, PEEK, PTFE, Thermoset polymers – Urea and Phenol formaldehydes –Nylon, Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON — intermetallics- Composites- Matrix and reinforcement Materials- applications of Composites - Nano composites.

UNIT V MECHANICAL PROPERTIES AND DEFORMATION MECHANISMS 9

Mechanisms of plastic deformation, slip and twinning – Types of fracture – fracture mechanics- Griffith's theory- Testing of materials under tension, compression and shear loads — Hardness

tests (Brinell, Vickers and Rockwell), Micro and nano-hardness tests, Impact test lzod and charpy, fatigue and creep failure mechanisms.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1. Explain alloys and phase diagram, Iron-Iron carbon diagram and steel classification.
2. Explain isothermal transformation, continuous cooling diagrams and different heat treatment processes.
3. Clarify the effect of alloying elements on ferrous and non-ferrous metals.
4. Summarize the properties and applications of non-metallic materials.
5. Explain the testing of mechanical properties.

Text Book(s):

1. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of IndiaPrivate Limited, 9th edition ,2018.
2. Sydney H.Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 1994

Reference Books:

1. A. Alavudeen, N. Venkateshwaran, and J. T.WinowlinJappes, A Textbook of Engineering Materialsand Metallurgy, Laxmi Publications, 2006.
2. Amandeep Singh Wadhwa, andHarvinder Singh Dhaliwal, A Textbook of Engineering Material andMetallurgy, University Sciences Press, 2008.
3. G.S. Upadhyay and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt.Ltd, NewDelhi, 2020.
4. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt.Ltd. 6th edition, 2019.
5. Williams D Callister, "Material Science and Engineering" Wiley India Pvt Ltd, 2nd edition Re print2019.

22ME404	**COMPUTER AIDED MACHINE DRAWING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Pre-requisite **Syllabus Version** V 0.1

Course Objectives:

1.To make the students understand and interpret drawings of machine components
2.To prepare assembly drawings both manually and using standard CAD packages
3.To familiarize the students with Indian Standards on drawing practices and standard components
4.To gain practical experience in handling 2D drafting software systems.

Course Content:

UNIT I DRAWING STANDARDS & FITS AND TOLERANCES 9

Code of practice for Engineering Drawing, BIS specifications — Welding symbols, riveted joints, keys, fasteners — Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. - Limits, Fits – Tolerancing of individual dimensions –

Specification of Fits –Preparation of production drawings and reading of part and assembly drawings, basic principles of geometric dimensioning & tolerancing.

UNIT II INTRODUCTION TO 2D AND MANUAL DRAWINGS 9

Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing. Bearings - Bush bearing, Plummer block. Valves – Safety and non-return valves.

List of manual drawings

1.piston ,2.connecting rod,3.plummer block,4.flange coupling, 5.Universal coupling 6.knuckle joint,7.cotter joint

UNIT III INTRODUCTION TO CAD

CAD (Computer Aided Design) is the use of computer software to design and document a product's design process- 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.

Expected Course Outcome: On completion of the course, the student is expected to

1. Follow the drawing standards, Fits and Tolerances
2. Re-create part drawings, sectional views and assembly drawings as per standards

Reference Books:

1. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner,Bangalore, 2013

Reference Books:

1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013
2. Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004
3. N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing" , published by Tata Mc GrawHill,2006
4. S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, NewDelhi, 2007

List of Experiments:

1.	Introduction to CADD	**3**
2.	Introduction to modeling software Pro-E	**3**
3.	2D Drafting of Plummer block bearing	**3**
4.	2D Drafting of Non-return valves	**3**
5.	2D Drafting of Safety valve	**3**
6.	3D Assembly of Flange Coupling	**3**
7.	3D Assembly of Universal Coupling	**3**
8.	3D Assembly of Oldham's Coupling	**3**
9.	3D Assembly of Knuckle joint	**3**
10.	3D Assembly of Socket and Spigot joint	**3**
11.	3D Assembly of Gib and Cotter joint	**3**
12.	3D Assembly of Connecting rod	**3**
13.	3D Assembly of Piston	**3**
14.	3D Assembly of Stuffing box	**3**
15.	3D Assembly of Crosshead	**3**

TOTAL PRACTICAL PERIODS 60 Periods

List of Equipments: (for batch of 30 students)

S.No	Description of Equipment	Quantity Required (R)
1	Computer Work station	15
2	Windows 11	
3	Auto CAD 2023 / Solid Works 2023 / Creo 9.0	15 License
4	Autodesk Inventor 2023.1.1	

22MC404	**Worth out of Waste**	**L**	**T**	**P**	**C**
		0	**0**	**0**	**0**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

To identify, develop, and deploy technologies to treat waste to generate energy, recycle materials, and extract worth. To train the students in preparing model, project reports and to face reviews and viva voce examination

The students in a group of 3 to 4 works on a topic related to conversion of waste out of wealth under the guidance of a faculty member and prepares a social responsible comprehensive project report with the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may 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.

Expected Course Outcome: On Completion of the project work students will be in a position

1. To take up any challenging practical problems and find solution by formulating proper methodology.
2. To minimize the volume of waste accumulation.

22ME501	THERMAL ENGINEERING	L	T	P	C
		3	0	2	4

Pre-requisite Thermodynamics **Syllabus Version** V 0.1

Course Objectives:

1. To learn the concepts and laws of thermodynamics to predict the operation of thermodynamic cycles and performance of Internal Combustion(IC) engines and Gas Turbines.
2. To analyzing the performance of steam nozzle, calculate critical pressure ratio.
3. To Evaluating the performance of steam turbines through velocity triangles, understand the need for governing and compounding of turbines.
4. To analyzing the working of IC engines and various auxiliary systems present in IC engines.
5. To evaluating the various performance parameters of IC engines.

Course Content:

UNIT I GAS POWER CYCLES 9

Air Standard Cycles - Otto, Diesel, Dual, Brayton – Cycle Analysis, Performance and Comparison.

UNIT II RECIPROCATING AIR COMPRESSOR 9

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling.

UNIT III GAS TURBINES & STEAM NOZZLE 9

Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combinations. Types and Shapes of nozzles, Flow of steam through nozzles, Critical pressure ratio, Variation of mass flow rate with pressure ratio. Effect of friction. Metastable flow.

UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE 9

IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison of SI and CI engines**.** Performance parameters and calculations. Morse and Heat Balance tests.

UNIT V ENGINE COMBUSTION AND ACCESSORIES 9

Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control. Multipoint Fuel Injection system and Common Rail Direct Injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply thermodynamic concepts to different air standard cycles and solve problems.
2. Solve problems in single stage and multistage air compressors

3.Explain the flow in Gas turbines and solve problems.
4.Explain the functioning and features of IC engines
5.Explain the functioning and features of IC engines combustion and accessories

Text Book(s):

1. Kothandaraman.C.P., Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2016
2. Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017

Reference Books:

1. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.
2. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi,2003
3. Sarkar, B.K,”Thermal Engineering” Tata McGraw-Hill Publishers, 2007

List of Experiments:

1.	Valve Timing and Port Timing diagrams.	3
2.	Actual p-v diagrams of IC engines.	3
3.	Performance Test on 4 – stroke Diesel Engine.	4
4.	Heat Balance Test on 4 – stroke Diesel Engine.	4
5.	Morse Test on Multi-cylinder Petrol Engine.	4
6.	Retardation Test on a Diesel Engine.	4
7.	Performance test on a two stage Reciprocating Air compressor	4
8.	Determination of p-θ diagram and heat release characteristics of an IC engine.	4
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipment’s: (for batch of 30 students)

1.	I.C Engine – 2 stroke and 4 stroke model	1 no
2.	Apparatus for Flash and Fire Point	1 no
3.	4-stroke Diesel Engine with mechanical loading.	1 no
4.	4-stroke Diesel Engine with hydraulic loading.	1 no
5.	4-stroke Diesel Engine with electrical loading.	1 no
6.	Multi-cylinder Petrol Engine	1 no
7.	Single cylinder Petrol Engine	1 no
8.	Data Acquisition system with any one of the above	1 no
9.	Steam Boiler with turbine setup	1 no
10.	Single/two stage reciprocating air compressor	1 no

22ME502	METROLOGY AND MEASUREMENTS	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn basic concepts of the metrology and importance of measurements.
2. To teach measurement of linear and angular dimensions assembly and transmission elements.
3. To study the tolerance analysis in manufacturing.
4. To develop the fundamentals of GD & T and surface metrology.
5. To provide the knowledge of the advanced measurements for quality control in manufacturing industries.

pricing financial accounting

Course Content:

UNIT I BASICS OF METROLOGY 9

Measurement – Need, Process, Role in quality control; Factors affecting measurement - SWIPE; Errors in Measurements – Types – Control – Measurement uncertainty – Types, Estimation, Problems on Estimation of Uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, Principle of air gauging-ISO standards.

UNIT II MEASUREMENT OF LINEAR, ANGULAR DIMENSIONS, ASSEMBLY AND TRANSMISSION ELEMENTS 9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments – Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope. Measurement of Screw threads - Single element measurements – Pitch Diameter, Lead, Pitch. Measurement of Gears – purpose – Analytical measurement – Runout, Pitch variation, Tooth profile, Tooth thickness, Lead – Functional checking – Rolling gear test.

UNIT III TOLERANCE ANALYSIS 9

Tolerancing– Interchangeability, Selective assembly, Tolerance representation, Terminology, Limits and Fits, Problems (using tables IS919); Design of Limit gauges, Problems. Tolerance analysis in manufacturing, Process capability, tolerance stackup, tolerance charting.

UNIT IV METROLOGY OF SURFACES 9

Fundamentals of GD & T- Conventional vs Geometric tolerance, Datums, Inspection of geometric deviations like straightness, flatness, roundness deviations; Simple problems – Measurement of Surface finish – Functionality of surfaces, Parameters, Comparative, Stylus based and Optical Measurement techniques, Filters, Introduction to 3D surface metrology-Parameters.

UNIT V ADVANCES IN METROLOGY 9

Lasers in metrology - Advantages of lasers – Laser scan micrometers; Laser interferometers – Applications – Straightness, Alignment; Ball bar tests, Computer Aided Metrology - Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multi sensor CMMs.

Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and inprocess monitoring in production - Computed tomography – White light Scanners.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Discuss the concepts of measurements to apply in various metrological instruments.
2. Apply the principle and applications of linear and angular measuring instruments, assembly and transmission elements.
3. Apply the tolerance symbols and tolerance analysis for industrial applications.
4. Apply the principles and methods of form and surface metrology.
5. Apply the advances in measurements for quality control in manufacturing Industries.

Text Book(s):

1. Dotson Connie, "Dimensional Metrology", Cengage Learning, First edition, 2012.
2. Mark Curtis, Francis T. Farago, "Handbook of Dimensional Measurement", Industrial Press, Fifth edition, 2013.

Reference Books:

1. AmmarGrous, J "Applied Metrology for Manufacturing Engineering", Wiley-ISTE, 2011.
2. Galyer, J.F.W. Charles Reginald Shotbolt, "Metrology for Engineers", Cengage Learning EMEA; 5th revised edition, 1990.
3. 3. National Physical LaboratoryGuideNo. 40, No. 41, No. 42, No. 43, No. 80, No. 118, No. 130, No. 131. http://www.npl.co.uk.
4. Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
5. Venkateshan, S. P., "Mechanical Measurements", Second edition, John Wiley &Sons, 2015

TOTAL LECTURE PERIODS 45 Periods

List of Experiments:

1.	Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks	3
2.	Calibration and use of measuring instruments – depth micrometer, bore gauge, telescopic gauge	3
3.	Measurement of linear dimensions using Comparators	3
4.	Measurement of angles using bevel protractor and sine bar	3
5.	Measurement of angles using bevel protractor and sine bar	3
6.	Measurement of gear parameters – disc micrometers, gear tooth vernier caliper	3
7.	Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector and Video measurement system	3
8.	Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus based instruments	3

9.	Machine tool metrology – Level tests using precision level; Testing of straightness of a machine tool guide way using Autocollimator, spindle tests	3
10	Measurement of force, torque and temperature	3
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	Micrometer	5
2.	Vernier Caliper	5
3.	Vernier Height Gauge	2
4.	Vernier depth Gauge	2
5.	Slip Gauge Set	1
6.	Slip Gauge Set	1
7.	Sine Bar	1
8.	Floating Carriage Micrometer	1
9.	Profile Projector / Tool Makers Microscope	1
10	Mechanical / Electrical / Pneumatic Comparator	1
11	Autocollimator	1
12	Temperature Measuring Setup	1
13	Force Measuring Setup	1
14	Torque Measuring Setup	1
15	Surface finish measuring equipment	1
16	Bore gauge	1
17	Telescope gauge	1

22ME503 DESIGN OF MACHINE ELEMENTS

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To familiarize the various steps involved in the Design Process
2. To understand the principles involved in evaluating the shape and dimensions of a component to satisfy functional and strength requirements.
3. To learn to use standard practices and standard data
4. To learn to use catalogues and standard machine components
   (Use of P S G Design Data Book is permitted)

Course Content:

UNIT I STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS 9

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 – calculation of principle stresses for

various load combinations, eccentric loading – curved beams – crane hook and 'C' frame- Factor of safety - theories of failure – Design based on strength and stiffness – stress concentration – Design for variable loading.

UNIT II SHAFTS AND COUPLINGS 9

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

UNIT III TEMPORARY AND PERMANENT JOINTS 9

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints – Welded joints, riveted joints for structures - theory of bonded joints.

UNIT IV ENERGY STORING ELEMENTS AND ENGINE COMPONENTS 9

Various types of springs, optimization of helical springs - rubber springs – Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts.

UNIT V BEARINGS 9

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi and Boyd graphs, -- Selection of Rolling Contact bearings.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1.Explain the influence of steady and variable stresses in machine component design.
2.Apply the concepts of design to shafts, keys and couplings.
3.Apply the concepts of design to temporary and permanent joints.
4.Apply the concepts of design to energy absorbing members, connecting rod and crank shaft.
5.Apply the concepts of design to bearings.

Text Book(s):

1. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co.(Schaum's Outline), 2010
2. Ansel Ugural, "Mechanical Design – An Integral Approach", 1 st Edition, Tata McGraw-Hill Book Co, 2003.

Reference Books:

1. Bhandari V, "Design of Machine Elements", 4 th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 9th Edition, Tata McGraw-Hill, 2011.
3. P.C. Gope, "Machine Design – Fundamental and Application", PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, "Design of Machine Elements", MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.

5. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4 th Edition, Wiley, 2005
6. Sundararajamoorthy T. V. Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2015.

22ME504	COMPUTER AIDED MODELING LAB	L	T	P	C
		3	0	3	2

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To give exposure to software tools needed to create and assemble engineering parts.
2. To give exposure to software tools needed to analyze engineering problems.

Course Content:

UNIT I CAD INTRODUCTION. 12

Sketcher - Solid modeling – Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc, Surface modeling –Extrude, Sweep, Trim, etc and Mesh of curves, Free form etc, Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc. Assembly - Constraints, Exploded Views, Interference check. Drafting - Layouts, Standard & Sectional Views, Detailing & Plotting

UNIT II DESIGN FOR MANUFACTURE AND ASSEMBLY LABORATORY 12

Introduction to Design for Assembly and Manufacturability (DFA/DFM)- The New Product Design (NPD) Process-Design for Assembly –Assembly Method Selection-Design forAssembly – Boothroyd - Dewhurst Method-Cost Estimation Using DFM. The students will be given training on the use and application of the following 1. DFMA software

Expected Course Outcome: At the end of the course the students would be able to

1. Convert 3D solid models into 2D drawing and prepare different views, sections and dimensioning of part models, process of DFA/DFM.

Text Book(s):

1.Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006.
2.William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1st Edition, 2001.

Reference Books:

1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C “Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2003

List of Experiments:

Exercises in modeling and drafting of mechanical components - assembly using parametric and feature based packages. 2D TO 3D conversion.

1.	Plate Assembly	3
2.	Bearing Block	3
3.	Hitch Mount	3
4.	Tower Assembly	3
5.	Screw jack Assembly	3
6.	Tailstock Assembly	**3**
7.	Sleeve and Cotter Joint	**3**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**45 Periods**

List of Equipments: (for batch of 30 students)

1.	Intel Octa core i9 processor	6 GHz, 16 GB Ram, 600 s8D HD- 50
2.	Windows 11	50 S7D Acad License
3.	Creo 9.0	50 S7D Acad License
4.	Solid Works 2023	50 S7D Acad License

22MC601 INDUSTRIAL SAFETY

L	T	P	C
0	**0**	**0**	**0**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To Understand the Introduction and basic Terminologies safety.
2. To enable the students to learn about the Important Statutory Regulations and standards.
3. To enable students to Conduct and participate the various Safety activities in the Industry.
4. To have knowledge about Workplace Exposures and Hazards.
5. To assess the various Hazards and consequences through various Risk Assessment Techniques.

Course Content:

UNIT I SAFETY TERMINOLOGIES 9

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS.

UNIT II STANDARDS AND REGULATIONS 9

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006.

UNIT III SAFETY ACTIVITIES 9

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment.

UNIT IV WORKPLACE HEALTH AND SAFETY 9

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety Toxic gas Release.

UNIT V HAZARD IDENTIFICATION TECHNIQUES 9

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basic concept of safety.
2. Obtain knowledge of Statutory Regulations and standards.
3. Know about the safety Activities of the Working Place.
4. Analyze on the impact of Occupational Exposures and their Remedies
5. Obtain knowledge of Risk Assessment Techniques.

Text Book(s):

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems Khanna Publisher
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

Reference Books:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring.(1996).Safety management system: Chapman &Hall,England 5. Society of Safety Engineers, USA

22ME601	HEAT AND MASS TRANSFER	L	T	P	C
		3	0	2	4

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the mechanisms of heat transfer under steady and transient conditions.
2. To understand the concepts of heat transfer through extended surfaces
3. To gain experimental knowledge of Testing the performance of tubes in tube heat exchangers
4. To learn the thermal analysis and sizing of heat exchangers and to understand the basic Concepts of mass transfer.

(Use of standard HMT data book permitted)

Course Content:

UNIT I CONDUCTION 9

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction –– plane and Composite Systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's

UNIT II CONVECTION 9

Free and Forced Convection - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through Tubes.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS 9

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 - Analysis – LMTD method - NTU method.

UNIT IV RADIATION 9

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation tubes

UNIT V MASS TRANSFER 9

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1.Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems.

2.Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.

3.Explain the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.

4.Explain basic laws for Radiation and apply these principles to radiative heat transfer

between different types of surfaces to solve problems.
5.Apply diffusive and convective mass transfer equations and correlations to solve Problems for different applications.

Text Book(s):

1. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2000
2. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition 2015
3. S. Chand., ”Heat and Mass Transfer",1st edition 2018
4. P K Nag., ”Heat and Mass Transfer" 3rd edition 2019

Reference Books:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 1998.
2. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 1998.
3. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. R.C. Sachdeva, “Fundamentals of Engineering Heat & Mass transfer”, New Age International Publishers, 2009

List of Experiments:

1.	Thermal conductivity measurement using guarded plate apparatus	**3**
2.	Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.	**3**
3.	Determination of heat transfer coefficient under natural convection from a vertical cylinder.	**3**
4.	Determination of heat transfer coefficient under forced convection from a tube.	**3**
5.	Determination of Thermal conductivity of composite wall.	**3**
6.	Determination of Thermal conductivity of insulating powder.	**3**
7.	Heat transfer from pin-fin apparatus (natural & forced convection modes)	**3**
8.	Determination of Stefan – Boltzmann constant.	**3**
9.	Determination of emissivity of a grey surface.	**3**
10.	Effectiveness of Parallel / counter flow heat exchanger.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	Guarded plate apparatus	01 no
2.	Lagged pipe apparatus	01 no
3.	Natural convection-vertical cylinder apparatus	01 no
4.	Forced convection inside tube apparatus	01 no
5.	Composite wall apparatus	01 no
6.	Thermal conductivity of insulating powder apparatus	01 no

7.	Pin-fin apparatus	01 no
8.	Stefan-Boltzmann apparatus	01 no
9.	Emissivity measurement apparatus	01 no
10.	Parallel/counter flow heat exchanger apparatus	01 no

22ME602	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To appreciate the use of FEM to a range of Engineering Problems.
3. Understand the fundamental ideas of FEA

Course Content:

UNIT I INTRODUCTION 9

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

UNIT II ONE-DIMENSIONAL PROBLEMS 9

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS 9

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS 9

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION 9

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to
1.Summarize the basics of finite element formulation.
2.Apply finite element formulations to solve one dimensional Problems.
3.Apply finite element formulations to solve two dimensional scalar Problem
4.Apply finite element method to solve two dimensional Vector problems.
5.Apply finite element method to solve problems on iso parametric element and dynamic Problems.

Text Book(s):

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3rd Edition, Tata McGraw-Hill, 2005
2. 2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Reference Books:

1. Bhatti Asghar M, "Fundamental Finite Element Analysis and Applications", John Wiley & Sons, 2005 (Indian Reprint 2013)*
2. Chandrupatla & Belagundu, “Introduction to Finite Elements in Engineering”, 3rd Edition, Prentice Hall College Div, 1990
3. Logan, D.L., “A first course in Finite Element Method”, Thomson Asia Pvt. Ltd., 2002
4. Rao, S.S., “The Finite Element Method in Engineering”, 3rd Edition, Butterworth Heinemann, 2004
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, “Concepts and Applications of Finite Element Analysis”, 4th Edition, Wiley Student Edition, 2002.

List of Experiments:

1.	Force and Stress analysis using link elements inTrusses, cables etc.	**3**
2.	Stress and deflection analysis in beams with different support conditions.	**3**
3.	Stressanalysisofflat platesandsimple shells.	**3**
4.	Stress analysis of axi–symmetric components.	**3**
5.	Thermal stress and heat transfer analysis of plates.	**3**
6.	Thermal stress analysis of cylindrical shells.	**3**
7.	Vibrationan alysis of spring-masssystems.	**3**
8.	Model analysis of Beams	**3**
9.	Harmonic analysis of simple systems.	**3**
10.	Transient and spectrum analysis of simple systems.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipments: (for batch of 30 students)

1.	Computer Work Station	15 nos
2.	Color Desk Jet Printer	05 nos
3.	C/MAT LAB	05 license

22ME603	HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
2. To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
3. To develop a measurable degree of competence in the design, construction and operation of fluid power circuits

Course Content:

UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids- Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory– Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders-Types and construction, Application, Hydraulic cushioning– Hydraulic motors-Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEM 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding,

Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the Fluid power and operation of different types of pumps.
2. Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
3. Explain the different types of Hydraulic circuits and systems
4. Explain the working of different pneumatic circuits and system
5. Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

Text Book(s):

1. Anthony esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw- Hill, 2001.
3. Andrew Parr.,"Hydraulics and Pneumatics", Re edition 2013.
4. S.Ilango.,"Introduction to Hydraulics and Pneumatics",Second edition 2011

Reference Books:

2. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
3. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
5. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
6. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

22EEC502	**MINI PROJECT**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1 The main objective is to give an opportunity to the student to get hands on training in the fabrication of one or more components of a complete working model, which is designed by them.
2.To discuss the notion of risks and the risk management process

Course Content:

GUIDELINE FOR REVIEW AND EVALUATION

The students may be grouped into 2 to 4 and 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 and internal examiners constituted by the Head of the Department.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Design and fabricate the machine element or the mechanical product.
2. Demonstrate the working model of the machine element or the mechanical product.

22ME701	MECHATRONICS AND IOT	L	T	P	C
		3	0	2	4

Syllabus Version V 0.1

Course Objectives:

1. To make students get acquainted with the sensors and the actuators, which are commonly used in mechatronics systems.
2. To provide insight into the signal conditioning circuits, and also to develop competency in PLC programming and control
3. To make students familiarize with the fundamentals of IoT and Embedded systems.
4. To impart knowledge about the Arduino and the Raspberry Pi.
5. To inculcate skills in the design and development of mechatronics and IoT based systems.

Course Content:

UNIT I SENSORS AND ACTUATORS 9

Introduction to Mechatronics - Modular Approach, Sensors and Transducers: Static and Dynamic Characteristics, Transducers - Resistive, Capacitive, Inductive and Resonant, Optical Sensors – Photodetectors - Vision Systems – Laser - Fibre optic - Non-fibre Optic, Solid State Sensors, Piezoelectric and Ultrasonic Sensors. Actuators – Brushless Permanent Magnet DC Motor – PM, VR and Hybrid Stepper motors – DC and AC Servo Motors

UNIT II SIGNAL CONDITIONING CIRCUITS AND PLC 9

Operational Amplifiers – Inverting and Non-Inverting Amplifier – Wheatstone bridge Amplifier – Instrumentation Amplifier – PID Controller, Protection Circuits, Filtering Circuits, Multiplexer, Data Logger and Data Acquisition System –, Switching Loads by Power Semiconductor Devices Circuits – Thyristors – TRIAC – Darlington Pair –MOSFET and Relays. PLC – Architecture – Input / Output Processing – Logic Ladder Programming – Functional Block Programming using Timers and Counters – Applications

UNIT III FUNDAMENTALS OF IoT AND EMBEDDED SYSTEMS 9

The Internet of Things (IoT) - Introduction to the IoT Framework – IoT Enabling Technologies- The Effective Implementation of IoT: The Detailed Procedure. Embedded Systems: An Introduction - Single-Chip Microcontroller Systems - Single-Board Microcontroller Systems - Single-Board Computer Systems - Embedded Systems: Peripherals - Software Considerations

UNIT IV CONTROLLERS 9

Foundation topics: Programming Languages: C++ and Python - The Linux Operating System. Arduino: The Arduino Boards - Arduino Peripherals- Arduino IDE – ESP8266 Wi-Fi module. Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals - The Raspberry Pi Operating System. (typical peripherals) Interfacing and Controlling I/O devices by Arduino and Raspberry Pi: LEDs - Push buttons - Light intensity sensor - Ultrasonic distance sensor – Temperature sensor- Humidity sensor - Sensor and Actuator interactions

UNIT V MECHATRONICS AND IoT CASE STUDIES 9

Mechatronics systems: Drone actuation and Control -Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

CO1: Explain Select suitable sensors and actuators to develop mechatronics systems.

CO 2. Discuss Devise proper signal conditioning circuit for mechatronics systems, and also able to implement PLC as a controller for an automated system.

CO 3. Elucidate the fundamentals ofIot and Embedded Systems

CO 4. Discuss Control I/O devices through Arduino and Raspberry Pi.

CO 5. Design and develop an apt mechatronics/IoT based system for the given real-time application.

Text Book(s):

1. Bradley D.A., Burd N.C., Dawson D., Loader A.J., "Mechatronics: Electronics in Products and Processes", Routledge, 2017.
2. Sami S.H and Kisheen Rao G "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022.

Reference Books:

1. John Billingsley, "Essentials of Mechatronics", Wiley, 2006
2. David H., Gonzalo S., Patrick G.,Rob B. and Jerome H.,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Pearson Education, 2018.
3. Nitin G and Sharad S, "Internet of Things: Robotic and Drone Technology", CRC Press, 2022
4. Newton C. Braga, "Mechatronics for The Evil Genius", McGrawHill, 2005.
5. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013

List of Experiments:

EQUIVALENT SOFTWARE PACKAGE/ PROCESSOR BASED IMPLEMENTATION

1. Interfacing and programming GPIO ports in using (blinking LEDs, push buttons)
2. Interfacing 3x3 Key pad matrix
3. Interrupt programming examples through GPIOs
4. Interfacing Temperature / LDR using ADC
5. Adjusting LED brightness using PWM / DAC
6. Communication interface: Serial (UART), Wireless connectivity – obtain IP address
7. Interfacing DHT sensor using one wire digital interface
8. Interfacing Stepper motor / Relay module through ULN2003

9. Implementing IOT Solution using HTTP protocol and visualizing data at
10. Implementing IOT Solution using MQTT protocol and visualizing data at

22HS703	HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To create an awareness on Engineering Ethics and Human Values.
2. To instil Moral and Social Values and Loyalty
3. To appreciate the rights of others.
4. To create awareness ethics

Course Content:

UNIT I CONCEPTS AND THEORIES OF HUMAN ETHICS 9

Concepts and theories of human Ethics: Definitions of Ethics, Personal ethics and professional ethics, Morality and law, how are moral standards formed? Religion and Morality, Morality, Etiquette and Professional codes, Indian Ethical Traditions.

UNIT II PROFESSIONAL ETHICS 9

Professional Ethics: Principles of personal Ethics, Principles of Professional ethics, Evolution of Ethics Over the years, Honesty, Integrity and Transparency are the touchstones of Business Ethics, Distinction Between Values and Ethics, Roots of unethical Behaviour, Ethical Decision – Making.

UNIT III ETHICAL DILEMMAS, SOURCES AND THEIR RESOLUTIONS 9

Ethical Dilemmas, Sources and Their resolutions: What is an Ethical Dilemma, Sources of Ethical Behaviour, Code of Personal Ethics for Employees, How to Resolve an Ethical Problem, How to Resolve Ethical Dilemmas.

UNIT IV ETHICAL DECISION 9

Ethical Decision – marking in Business: Ethical Models that Guide Decision making, Which Approach to use, Ethical Decision Marking with Cross – holder conflicts and competition, Applying Moral Philosophy to Ethical Decision Making, Kohlberg's Model of Cognitive Moral Development, Influences on Ethical Decision Making, Personal values and Ethical Decision Marking.

UNIT V INDIVIDUAL FACTORS 9

Individual factors: Moral Philosophies and values – Moral Philosophy defined, Moral philosophies, Applying Moral Philosophy to Ethical decision Making, Cognitive moral Development, White – Collar Crime, Individual factors in Business Ethics. Human Values for Indian, Lessons from Ancient Indian Education system, The law of Karma, Quality of Working life, Ethics of Vivekananda, Gandhiji, Aurobindo and Tagore.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. Awareness of types of ethical challenges and dilemmas confronting members of a range of professions (business, media, police, law, medicine, research).
2. Identify and describe relevant theoretical concepts related to professional ethics in engineering.

3. Distinguish among morals, values, ethics, and the law and to explore how they each impact engineering practice.
4. Apply learning from Indian history and ethos to ethical practices in engineering.

Text Book(s):

1. M.Govindarajan, S.Natarajananad, V.S.SenthilKumar "Engineering Ethics includes Human Values" - PHI Learning Pvt. Ltd-2009
2. Harris, Pritchard and Rabins "Engineering Ethics", CENGAGE Learning, India Edition, 2009.
3. Mike W. Martin and Roland Schinzinger "Ethics in Engineering" Tata McGraw- Hill–2003.
4. Prof.A.R.Aryasri, DharanikotaSuyodhana "Professional Ethics and Morals" Maruthi Publications.
5. A.Alavudeen, R.KalilRahman and M.Jayakumaran "Professional Ethics and Human Values" – LaxmiPublications.
6. Prof.D.R.Kiran "Professional Ethics and Human Values"
7. PSR Murthy "Indian Culture, Values and Professional Ethics" BS Publication

Reference Books:

1. Business Ethics by AC Fernando
2. Business Ethics by Ferrell, Fraedrich and Ferrell.
3. Ethics in Management and Indian Ethos by Biswanath Gosh

22EEC701	**PROJECT WORK - PHASE I**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Pre-requisite Nil **Syllabus Version** V 0.1

The students in a group of 3 to 4 works 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 may 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, evaluated by the Internal committee approved by the Head of the department.

TOTAL PRACTICAL PERIODS 60 Periods

Expected Course Outcome:

On completion of the course, the student is expected to On Completion of the project work students will be in a position to take up anychallenging practical problems and find solution by formulating proper methodology

22MG801	INDUSTRIAL MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Understand the philosophies of management gurus
2. Understand the various types of organization structures and their features, and Their advantages and disadvantages.
3. Learning various Industrial Engineering Practices like Operations Management techniques, work study, statistical quality control techniques, Job evaluation techniques and network analysis techniques.

Course Content:

UNIT I INTRODUCTION TO MANAGEMENT 9

Entrepreneurship and organization – Nature and Importance of Management, Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management.

UNIT II DESIGNING ORGANIZATIONAL STRUCTURES 9

Departmentalization and Decentralization, Types of Organization structures – Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

UNIT III OPERATIONS MANAGEMENT 9

Objectives- product design process- Process selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison- Types of Plant Layouts-Design of product layout- Line balancing (RPW method) Value analysis-Definition-types of values-Objectives- Phases of value analysis- Fast diagram.

UNIT IV WORK STUDY 9

Work Study: Introduction — definition — objectives — steps in work study — Method study — definition, objectives — steps of method study. Work Measurement — purpose — types of study — stop watch methods — steps — key rating — allowances — standard time calculations — work sampling.

UNIT V STATISTICAL QUALITY CONTROL 9

Statistical Quality Control: variables-attributes, Shewart control charts for variables- chart, R chart, – Attributes- Defective-Defect- Charts for attributes-p-chart - c chart (simple Problems), Acceptance Sampling- Single sampling- Double sampling plans-OC curves.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to
1. Able to apply principles of management
2. Able to design the organization structure
3. Able to apply techniques for plant location, design plant layout and value analysis
4. Able to carry out work study to find the best method for doing the work and establish standard time for a given method
5. Able to apply various quality control techniques and sampling plans, job evaluation and network analysis.

Text Book(s):
1. Industrial Engineering and Management/O.P. Khanna/Khanna Publishers.
2. Industrial Engineering and Management Science/T.R. Banga and S.C. Sarma/Khanna Publishers.

Reference Books:
1. Motion and Time Study by Ralph M Barnes! John Willey & Sons Work Study by lLO.
2. Human factors in Engineering & Design/Ernest J McCormick /TMH.
3. Production & Operation Management /Paneer Selvam/PHI.
4. Industrial Engineering Management/NVS Raju/Cengage Learning.
5. Industrial Engineering Hand Book/Maynard.
6. Industrial Engineering Management I Ravi Shankar/Galgotia.

22EEC801	**PROJECT WORK – PHASE II**	**L**	**T**	**P**	**C**
		0	**0**	**20**	**10**

Pre-requisite **Syllabus Version** V 0.1

Course Objectives:
To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination
The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares 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 may 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.

TOTAL PRACTICAL PERIODS **300 Periods**

Expected Course Outcome:
On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

22PME01	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system

Course Content:

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines – components-functions and materials, variable valve timing (VVT).

UNIT II 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), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, 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 IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Recognize the various parts of the automobile and their functions and materials.
2. Discuss the engine auxiliary systems and engine emission control.
3. Distinguish the working of different types of transmission systems.
4. Explain the Steering, Brakes and Suspension Systems.
5. Predict possible alternate sources of energy for IC Engines.

Text Book(s):

Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.

Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 13th Edition 2014.

Reference Books:

1. Anesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
2. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
3. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
4. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart - Will Cox Company Inc, USA ,1978.
5. Newton ,Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989.

22PME02	WELDING TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the basics of welding
2. To know about the various types of welding processes
3. To understand the principles of various solid state welding process.
4. To understand the concepts on weld joint design, weldability and testing of weldments.

Course Content:

UNIT I GAS AND ARC WELDING PROCESSES 9

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications.

UNIT II RESISTANCE WELDING PROCESSES 9

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

UNIT III SOLID STATE WELDING PROCESSES 9

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications.

UNIT IV OTHER WELDING PROCESSES 9

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

UNIT V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9

Various weld joint designs – Welding defects – causes and remedies - Weldability of Aluminium, Copper, and Stainless steels. Destructive and non destructive testing of weldments.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the construction and working principles of gas and arc welding process
2. Understand the construction and working principles of resistance welding process
3. Understand the construction and working principles of various solid state welding process.
4. Understand the construction and working principles of various special welding.
5. Understand the concepts on weld joint design, weldability and testing of weldments.

Text Book(s):

1. Little R.L., “Welding and welding Technology”, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
2. Parmer R.S., “Welding Engineering and Technology”, 1st Edition, Khanna Publishers, New

Delhi, 2008.
3. Parmer R.S., “Welding Processes and Technology”, Khanna Publishers, New Delhi, 1992.

Reference Books:

1. AWS- Welding Hand Book. 8th Edition. Vol- 2. “Welding Process”
2. Christopher Davis. “Laser Welding- Practical Guide”. Jaico Publishing House
3. Davis A.C., “The Science and Practice of Welding”, Cambridge University Press, Cambridge, 1993
4. Nadkarni S.V. “Modern Arc Welding Technology”, Oxford IBH Publishers, 1st Edition, 2005.
5. Schwartz M.M. “Metals Joining Manual”. McGraw Hill Books, 1979

22PME03	**ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the functions of the basic components of a Robot.
2. To study the use of various types of End of Effectors and Sensors
3. To impart knowledge in sensors
4. To study about machine vision system
5. To learn Robot safety issues and economics.

Course Content:

UNIT I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Robot Anatomy - Co ordinate 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.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison 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 III SENSORS 9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors.

UNIT IV MACHINE VISION 9

Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the concepts of industrial robots, classification, specifications and coordinate systems. Also summarize the need and application of robots in different sectors
2. Illustrate the different types of robot drive systems as well as robot end effectors.
3. Apply the different sensors in robotics to improve the ability of robots.
4. Explain the concepts of image processing techniques
5. Examine the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.

Text Book(s):

1. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2012.
2. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”,Prentice Hall, 2003.

Reference Books:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 2013.
3. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
4. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
5. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.

22PBM32	**INTELLECTUAL PROPERTY RIGHTS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

6. To give an idea about IPR, registration and its enforcement.

Course Content:

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTOto WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 9

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 9

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs 9

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Know about the Intellectual Property - Patents, Copyrights
2. Gain the ability to register practical and industrial design patents
3. Know about agreements and legislations related to IPRs
4. Implement to digital products and law
5. manage enforcement of IPRs

Text Book(s):

1. S.V. Satarkar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.

Reference Books:

1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli,”Intellectual Property Rights: Unleashing the Knowledge Economy”, McGrawHill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

Course Code	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the basics of drone concepts
2. To learn and understand the fundaments of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

Course Content:

UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

UNIT IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1. Know about a various type of drone technology, drone fabrication and programming.
2. Execute the suitable operating procedures for functioning a drone
3. Select appropriate sensors and actuators for Drones

4. Develop a drone mechanism for specific applications
5. Create the programs for various drones

Text Book(s):

1.Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.

2.Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016

Reference Books:

1.John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016

2.Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

Course Code	**POWER PLANT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite	**Nil**	**Syllabus Version**	**V 0.1**

Course Objectives:

Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance

Course Content:

UNIT I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III 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 IV POWER FROM RENEWABLE 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, Geo Thermal, Biogas and Fuel Cell power systems

UNIT V	**ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS**	**9**

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the layout, construction and working of the comonents inside a thermal power plant.
2. Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
3. Explain the layout, construction and working of the components inside nuclear power plants.
4. Explain the layout, construction and working of the components inside Renewable energy power plants.
5. 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

Text Book(s):

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd., 2008.

Reference Books:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.

22PME06	**GAS DYNAMICS AND JET PROPULSION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

6. To study the fundamentals of compressible flow concepts and the use of gas tables.
7. To learn the compressible flow behaviour in constant area ducts.
8. To study the development of shock waves and its effects.
9. To study the types of jet engines and their performance parameters.
10. To learn the types of rocket engines and their performance parameters.

Course Content:

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables.

UNIT II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply the fundamentals of compressible flow concepts and the use of gas tables.
2. Analyze the compressible flow behaviour in constant area ducts.
3. Analyze the development of shock waves and its effects.
4. Explain the types of jet engines and their performance parameters.
5. Explain the types of rocket engines and their performance parameters.

Text Book(s):

1. Anderson, J.D., “Modern Compressible flow”, Third Edition, McGraw Hill, 2003.
2. S.M. Yahya, “Fundamentals of Compressible Flow with Aircraft and Rocket propulsion”, New Age International (P) Limited, 4th Edition, 2012.

REFERENCES:

Reference Books:

1. R. D. Zucker and O Biblarz, “Fundamentals of Gas Dynamics”, 2nd edition, Wiley, 2011.
2. Balachandran, P., “Fundamentals of Compressible Fluid Dynamics”, Prentice-Hall of India, 2007.
3. Radhakrishnan, E., “Gas Dynamics”, Printice Hall of India, 2006.
4. Hill and Peterson, “Mechanics and Thermodynamics of Propulsion”, Addison – Wesley, 1965
5. Babu, V., “Fundamentals of Compressible Flow”, CRC Press, 1st Edition, 2008.

22PME07	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2. To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
3. To study the Vapour absorption and air refrigeration systems.
4. To learn the psychrometric properties and processes.
5. To study the air conditioning systems and load estimation.

Course Content:

UNIT I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system -low temperature refrigeration - Cascade systems – problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic- Vortex and Pulse tube refrigeration systems.

UNIT IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system;Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors,Actuators & Safety controls.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the basic concepts of Refrigeration
2. Explain the Vapor compression Refrigeration systems and to solve problems
3. Discuss the various types of Refrigeration systems
4. Calculate the Psychrometric properties and its use in psychrometric processes
5. Explain the concepts of Air conditioning and to solve problems

Text Book(s):

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi, 2010
2. Textbook of Refrigeration And Air-Conditioning (M.E.)by R.S. Khurmi

Reference Books:

1. ASHRAE Hand book, Fundamentals, 2010
2. JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann,2007
3. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
4. Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
5. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013

22PME08	**TURBOMACHINERY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To study the energy transfer in rotor and stator parts of the turbo machines.
2. To study the function of various elements of centrifugal fans and blowers.
3. To evaluating the working and performance of centrifugal compressor
4. To analyzing flow behavior and flow losses in axial flow compressor.
5. To study the types and working of axial and radial flow turbines.

Course Content:

UNIT I WORKING PRINCIPLES 9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT III CENTRIFUGAL COMPRESSOR 9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and

Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

UNIT IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

UNIT V AXIAL AND RADIAL FLOW TURBINES 9

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers
3. Evaluate the working and performance of centrifugal compressor.
4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines

Text Book(s):

1.Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

Reference Books:

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth- Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

22PME09	**INTERNAL COMBUSTION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To To study the working of Gasoline fuel injection systems and SI combustion.
2. To study the working of Diesel fuel injection systems and CI combustion.
3. To Identifying the source and measure it; explain the mechanism of emission formation and control methods.
4. To study the Selecting alternative fuel resources and its utilization techniques in IC

engines.

5. study the advanced combustion modes and future power train systems.

Course Content:

UNIT I SPARK IGNITION ENGINES 9

Mixture requirements – Fuel injection systems – Mono-point, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems – Mechanical and Common Rail Direct Injection Systems - Stages of combustion – Knocking – Factors affecting knock –Direct and Indirect injection systems –Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Combustion chambers – Turbo charging – Waste Gate, Variable Geometry turbochargers.

UNIT III EMISSION FORMATION AND CONTROL 9

Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling emissions – In-cylinder treatments – After treatment systems – Three Way Catalytic converter, Selective Catalytic Reduction, De-NOx Catalyst, Diesel Oxidation Catalyst and Particulate Traps – Methods of emission measurement – Emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS 9

Alcohol Fuels, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits – Utilisation Methods - Engine Modifications.

UNIT V ALTERNATE COMBUSTION AND POWER TRAIN SYSTEM 9

Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI - Hybrid Electric and Electric Vehicles –- Fuel Cells.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the working of Gasoline fuel injection systems and SI combustion.
2. Explain the working of Diesel fuel injection systems and CI combustion.
3. dentify the source and measure it; explain the mechanism of emission formation and control methods.
4. Select alternative fuel resources and its utilization techniques in IC engines.
5. Explain advanced combustion modes and future power train systems.

Text Book(s):

1. Ganesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

Reference Books:

1. B.P. Pundir, “IC Engines Combustion & Emission”, Narosa Publishing House, 2014.
2. Duffy Smith, “Auto Fuel Systems”, The Good Heart Wilcox Company, Inc., 2003.

3. EranSher, Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control,Academic Press, 1998.
4. K.K. Ramalingam, “Internal Combustion Engine Fundamentals”, SciTech Publications, 2011.
5. R.B. Mathur and R.P. Sharma, “Internal Combustion Engines”, Dhanpat Rai& Sons, 2007

22PME10 **DESIGN OF TRANSMISSION SYSTEMS**

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

7. To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
8. To understand the standard procedure available for Design of Transmission of Mechanical elements.
9. To learn to use standard data and catalogues

(Use of P S G Design Data Book permitted)

Course Content:

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

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

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEAR 9

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

UNIT III BEVEL, WORM AND CROSS HELICAL 9

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

UNIT IV GEAR BOXES 9

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 - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V CAMS, CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply the concepts of design to belts, chains and rope drives.
2. Apply the concepts of design to spur, helical gears.

3. Apply the concepts of design to worm and bevel gears.
4. Apply the concepts of design to gear boxes .
5. Apply the concepts of design to cams, brakes and clutches

Text Book(s):

6. Bhandari V, "Design of Machine Elements", 4 th Edition, Tata McGraw-Hill Book Co, 2016.
7. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 8 th Edition, Tata McGraw-Hill, 2008.

Reference Books:

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, "Design of Machine Elements 8th Edition, Printice Hall, 2003.
2. Orthwein W, "Machine Component Design", Jaico Publishing Co, 2003.
3. Prabhu. T.J., "Design of Transmission Elements", Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", 4th Edition, Wiley, 2005
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 2003.

22PME11	**DYNAMICS OF MACHINES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
2. To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
3. To understand the effect of Dynamics of undesirable vibrations.
4. To understand the principles in mechanisms used for speed control and stability control

Course Content:

UNIT I FORCE ANALYSIS 9

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels

UNIT II BALANCING 9

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

UNIT III FREE VIBRATION 9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 9

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

UNIT V MECHANISM FOR CONTROL 9

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes –Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Calculate static and dynamic forces of mechanisms.
2. Calculate the balancing masses and their locations of reciprocating and rotating masses.
3. Compute the frequency of free vibration.
4. Compute the frequency of forced vibration and damping coefficient.
5. Calculate the speed and lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.

Text Book(s):

1. F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
2. Rattan, S.S, “Theory of Machines”, 4 th Edition, Tata McGraw-Hill, 2014. 3. Uicker J. JPennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”,4th Edition Oxford University Press, 2014.

Reference Books:

1. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014
2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3 rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Khurmi, R.S.,”Theory of Machines”, 14th Edition, S Chand Publications, 2005.
4. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009. 6. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

22PME12	COMPUTER AIDED DESIGN	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide an overview of how computers are being used in mechanical component design.
2. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
3. To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.

Course Content:

UNIT I INTRODUCTION 9

Product cycle- Design process - sequential and concurrent engineering- Computer aided design – CAD system architecture- Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - Line drawing -Clipping- viewing transformation-Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM –CAD/CAM concepts —Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance

UNIT II GEOMETRIC MODELING 9

Representation of curves- Hermite curve- Bezier curve- B-spline curves-rational curves- Techniques for surface modeling – surface patch- Coons and bicubic patches- Bezier and B-spline surfaces. Solid modeling techniques- CSG and B-rep

UNIT III CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. - communication standards

UNIT IV CURVES AND SURFACES MODELLING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT V NURBS AND SOLID MODELING 9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry- comparison of representations - user interface for solid modeling.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the 2D and 3D transformations, clipping algorithm, Manufacturing models and Metrics.
2. Explain the fundamentals of parametric curves, surfaces and Solids.
3. Summarize the different types of Standard systems used in CAD.
4. Formulate the basic mathematics fundamental to CAD system.
5. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling

Text Book(s):

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill PublishingCo.2007
2. Boothroyd, G, "Assembly Automation and Product Design" Marcel Dekker, New York, 1997.
3. Chitale A.K and Gupta R.C "Product design and manufacturing " PHI learning private limited, 6th Edition, 2015

Reference Books:

1. David Rogers, James Alan Adams "Mathematical Elements for Computer Graphics" 2nd Edition, Tata McGraw-Hill edition.2003
2. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc., 2 nd Edition, 1996.
3. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006.
4. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1st Edition, 2001.

22PME13	**DESIGN OF JIGS, FIXTURES AND PRESS TOOLS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite **Nil** **Syllabus Version** **V 0.1**

Course Objectives:

1. To understand the functions and design principles of Jigs, fixtures and press tools.
2. To gain proficiency in the development of required views of the final design.

Course Content:

UNIT I LOCATING AND CLAMPING PRINCIPLES 9

Objectives of tool design- Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Redundant Location – Principles of clamping – Mechanical actuation – pneumatic and hydraulic actuation Standard parts – Drill bushes and Jig buttons – Tolerances and materials used.

UNIT II IGS AND FIXTURES 9

design and development of jigs and fixtures for given component- Types of Jigs – Post, Turnover, Channel, latch, box, pot, angular post jigs – Indexing jigs – General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

UNIT III PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES 9

Press Working Terminologies - operations – Types of presses – press accessories – Computation of press capacity – Strip layout – Material Utilization – Shearing action – Clearances – Press Work Materials – Center of pressure- Design of various elements of dies – Die Block – Punch holder, Die set, guide plates – Stops – Strippers – Pilots – Selection of Standard parts – Design and preparation of four standard views of simple blanking, piercing, compound and progressive dies.

UNIT IV BENDING AND DRAWING DIES 9

Difference between bending and drawing – Blank development for above operations – Types of Bending dies – Press capacity – Spring back – knockouts – direct and indirect – pressure pads – Ejectors – Variables affecting Metal flow in drawing operations – draw die inserts – draw beads- ironing – Design and development of bending, forming, drawing, reverse redrawing and combination dies – Blank development for axisymmetric, rectangular and elliptic parts – Single and double action dies.

UNIT V FORMING TECHNIQUES AND EVALUATION 9

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Summarize the different methods of Locating Jigs and Fixtures and Clamping principles.
2. Design and develop jigs and fixtures for given component.
3. Discuss the press working terminologies and elements of cutting dies.
4. Distinguish between Bending and Drawing dies.
5. Discuss the different types of forming techniques.

Text Book(s):

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2010.
2. Joshi P.H “Press tools - Design and Construction”, wheels publishing, 1996

Reference Books:

1. ASTME Fundamentals of Tool Design Prentice Hall of India.
2. Design Data Hand Book, PSG College of Technology, Coimbatore.
3. Donaldson, Lecain and Goold “Tool Design”, 5th Edition, Tata McGraw Hill, 2017.
4. Hoffman “Jigs and Fixture Design”, Thomson Delmar Learning, Singapore, 2004.

Kempster, “Jigs and Fixture Design”, Third Edition, Hoddes and Stoughton, 1974.

5.Venkataraman. K., “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, New Delhi, 2005.

22PME14	TOOL DESIGN	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

Course Content:

UNIT I INTRODUCTION TO MACHINE TOOL DESIGN 9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT II REGULATION OF SPEEDS AND FEEDS 9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.

UNIT III DESIGN OF MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage.

UNIT IV DESIGN OF GUIDEWAYS AND POWER SCREWS 9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

UNIT V DESIGN OF SPINDLES AND SPINDLE SUPPORT 9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings

Text Book(s):

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 3rd edition 2012

2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2015

Reference Books:

1. K Pal, S. K. Basu, "Design of Machine Tools", 6th Edition. Oxford IBH, 2014
2. N. S. Acherkhan, "Machine Tool Design", Volume 2 University Press of the Pacific, 2000
3. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964
4. F. Koenigsberger, Machine Tool Structures, Pergamon Press,1970.

22PME15	**PRODUCTION PLANNING AND CONTROL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.

2.To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

Course Content:

UNIT I INTRODUCTION 9

Objectives and benefits of planning and control-Functions of production control-Types of production- job- batch and continuous-Product development and design-Marketing aspect - Functional aspects- Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration- Standardization, Simplification & specialization-Break even analysis-Economics of a new design.

UNIT II WORK STUDY 9

Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

UNIT III 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 IV 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 V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1.Upon completion of this course, the students can able to prepare production planning and control activities such as work study, product planning, production scheduling, Inventory Control.

2.They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

Text Book(s):

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.

Reference Books:

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.

4.Kanishka Bedi, “Production and Operations management”, 2nd Edition, Oxford university press, 2007.

5.Melynk, Denzler, “ Operations management – A value driven approach” Irwin Mcgraw hill.

6.Norman Gaither, G. Frazier, “Operations Management” 9th Edition, Thomson learning IE, 2007

7.Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corpn.1984

8.Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007

Course Code	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the process planning concepts to make cost estimation for various products after process planning

Course Content:

UNIT I INTRODUCTION TO PROCESS PLANNING 9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

UNIT II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

UNIT III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labor cost, material cost-allocation of over head charges- Calculation of depreciation cost

UNIT IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1.select the process, equipment and tools for various industrial products
2.prepare process planning activity chart.
3.explain the concept of cost estimation.
4.compute the job order cost for different type of shop floor.
5.calculate the machining time for various machining operations.

Text Book(s):

1.Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technology Books, Dec 2002.
2.Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

Reference Books:

1.Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2.Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley,1998.
3.Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.
4.Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
5.K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

Course Code	**NON DESTRUCTIVE TESTING AND EVALUATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:
1.To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

Course Content:

UNIT I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided

UNIT II SURFACE NDE METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 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 IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9

Ultrasonic 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 V RADIOGRAPHY (RT) 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1.Explain the fundamental concepts of NDT

2,Discuss the different methods of NDE

3.Explain the concept of Thermography and Eddy current testing

4.Explain the concept of Ultrasonic Testing and Acoustic

5.Emission Explain the concept of Radiography

Text Book(s):

1.Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2014.

2.Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010

Reference Books:

1.ASM Metals Handbook, ”Non-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

2.ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

3.Charles, J. Hellier,“ Handbook of Nondestructive evaluation”, McGraw Hill, New York 2001.

4.Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005

Course Code	**QUALITY CONTROL AND RELIABILITY ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To introduce the concept of SQC

2.To understand process control and acceptance sampling procedure and their application.

3.To learn the concept of reliability.

Course Content:

UNIT I INTRODUCTION AND PROCESS CONTROL FOR VARIABLES 9

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation – Theory of control chart- uses of control chart –X chart, R chart and chart - process capability – process capability studies and simple problems. Six sigma concepts

UNIT II PROCESS CONTROL FOR ATTRIBUTES 9

Control chart for attributes –control chart for non conformings– p chart and np chart – control chart for nonconformities– C and U charts, State of control and process out of control identification in charts, pattern study.

UNIT III 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 IV LIFE TESTING – RELIABILITY 9

Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

UNIT V QUALITY AND RELIABILITY 9

Reliability improvements – techniques- use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development–Product life cycles.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1.Summarize the concept of Quality and Process control for variables
2.Apply the process control for attributes
3.Explain the concept of sampling and to solve problem
4.Explain the concept of Life testing
5.Explain the concept Reliability and techniques involved

Text Book(s):

1.Douglas.C. Montgomery, "Introduction to Statistical quality control", 7th 2012.
2.Srinath. L.S., "Reliability Engineering", Affiliated East west press, 2008.edition, John Wiley

Reference Books:

1.Besterfield D.H., "Quality Control", Prentice Hall, 2013.
2.Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 2012
3.Danny Samson, "Manufacturing & Operations Strategy", Prentice Hall, 1991
4.Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 2017
5.Gupta. R.C, "Statistical Quality control", Khanna Publishers, 2001.

22PME19	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.To introduce the basics of 6 SIGMA
2.To learning about the lean manufacturing tools.
3.To study about the deeper understanding methodologies of Lean manufacturing.
4.To study the lean concepts and its elements.
5. To learn implementation and challenges of lean manufacturing.

Course Content:

UNIT I BASICS OF 6 SIGMA 9

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standarddeviation, normal distribution, various sigma levels with some examples, value for theenterprise, Variation, and sources of variation, Mean and moving the mean, Various qualitycosts, cost of poor quality.

UNIT II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction toFMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, andProcess Management DMEDI for process creation, DMAIC for process improvement andPDCA for sustaining improvements.

UNIT III DEEPER UNDERSTADING METHODOLOGIES 9

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT IV LEAN ELEMENTS 9

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects.

UNIT V IMPLEMENTATION AND CHALLENGES 9

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to
1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.
3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

Text Book(s):
1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3. The Toyota Way: 14 Management Principles
4. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy,Masaki Imai

Reference Books:
1.Quality Councilof India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/
2. International Society of Six Sigma Professionals: https://isssp.org/about-us/
3. NPTEL / SWAYAM: https://nptel.ac.in/courses/110105123 :Six Sigma, Prof. Jitesh J Thakkar, IIT Kharagpur, Certification course. (Self- Learning).
4. Older / Previous editions of AIAG manuals on APQP, FMEA and PPAP. These are great sources of information on Quality Planning and has basics of Project Management and required skills.
5. Quality Management for Organizations Using Lean Six Sigma Techniques- Erick C Jones

22PME20	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To facilitate the understanding of Quality Management principles and process
2. To learn the fundamental concepts of Leadership and Motivation
3. To educate the tools of quality and its applications
4. To familiarize the fundamental concepts of quality improvements and measures
5. To understand the importance of quality management system and standards

Course Content:

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES - I 9

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

UNIT IV TQM TOOLS AND TECHNIQUES - II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. support to implement Quality Management principles
2. build the strong Leadership and assist for continuous improvement
3. implement tools of quality for various applications
4. Improve the quality of the process in all aspects

5. accomplish the quality management system and its standards

Text Book(s):

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8 th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO 9001-2015 standards

22PME21	**ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To enable the students to study the Managerial Economics, to study the demand and supply analysis
2. To learn about production and cost analysis and pricing and financial accounting

Course Content:

UNIT I INTRODUCTION 9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.

UNIT II DEMAND & SUPPLY ANALYSIS 9

Demand - Types of demand - Determinants of demand - Demand function - Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function - Supply elasticity

UNIT III PRODUCTION AND COST ANALYSIS 9

Production function - Returns to scale - Production optimization - Least cost input - Isoquants- Managerial uses of production function.
Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

UNIT IV PRICING 9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

UNIT V FINANCIAL ACCOUNTING 9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand concepts of Managerial Economics
2. Study the demand and supply analysis
3. Understand the concept of production and cost analysis.
4. Know about the concept of pricing.
5. Implement the concept of financial accounting.

Text Book(s):

1. Samuelson. Paul A and Nordhaus W.D., 'Economics', Tata Mcgraw Hill Publishing Company Limited, New Delhi, 2004.
2. McGuigan, Moyer and Harris, 'Managerial Economics; Applications, Strategy and Tactics', Thomson South Western, 10th Edition, 2005.

Reference Books:

1. Paresh Shah, 'Basic Financial Accounting for Management', Oxford University Press, New Delhi, 2007.
2. Salvatore Dominick, 'Managerial Economics in a global economy'. Thomson South Western, 4th Edition, 2001.
3. Prasanna Chandra. 'Fundamentals of Financial Management', Tata Mcgraw Hill Publishing Ltd., 4th edition, 2005.

22PME22 ENERGY STORAGE DEVICES

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Composites are a relatively new class of materials. In this course the students learn about the benefits gained when combining different materials into a composite.
2. The Motive is to make the students to understand different processing methods, issues, properties and testing methods of different composite materials

Course Content:

UNIT I ENERGY DEMAND 9

Oil, gas and electricity fuel industrial growth- Energy demand analysis-Causes for groth of energy demand- Final energy demand

UNIT II ENERGY SOURCES 9

Estimating energy requirements- Indian energy sources. Non-conventional renewable energy sources. Potential of renewable energy sources. Solar energy types. Wind energy. Wave, tidal and OTEC. Super-conductors in power system.

UNIT III NEED OF ENERGY STORAGE 9

Importance of Energy Storage System (ESS)-Energy Storage Technologies-Needs for energy storage in renewable energy-Benefits of energy storage

UNIT IV DIFFERENT MODES OF ENERGY STORAGE 9

Potential energy: Pumped hydro storage; KE and Compressed gas system: Flywheel storage, compressed air energy storage; Electrical and magnetic energy storage: Capacitors, electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage. Solar Ponds for energy storage

UNIT V ELECTROCHEMICAL ENERGY STORAGE SYSTEMS 9

Batteries: Primary, Secondary batteries; difference between primary and secondary batteries, chemistries of primary batteries such as Zinc-Carbon, Alkaline and secondary batteries such as Lead acid, Nickel Cadmium, Metal hydrides, lithium ion, lithium phosphate and high temperature batteries- sodium-sulphur. Advantages, disadvantages, limitations and application each above mentioned batterie

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain and use different modes of energy storage
2. Design and use of fuel cell for energy storage
3. Perform calculation regarding energy efficiency

Text Book(s):

1. Materials characterization, Vol. 10, ASM hand book
2. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
3. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker 4. Engineering

Reference Books:

1. Johannes Jensen Bent Squrensen, “Fundamentals of Energy Storage”, John Wiley, NY , 1984.
2. IEE Energy Series’ “Electro-chemical Power Sources”.
3. P.D.Dunn, “Renewable Energies”. First Edition, Peter Peregrinus Ltd, London, United Kingdom , 1986
4. S Srinivasan, “Fuel Cells: From Fundamentals to Applications”, Springer 2006
5. O’Hayre, SW Cha, W Colella and FB Prinz, “Fuel Cell Fundamentals”, Wiley, 2005

22PME23	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Composites are a relatively new class of materials.
2. In this course the students learn about the benefits gained when combining different materials into a composite.
3. The Motive is to make the students to understand different processing methods, issues, properties and testing methods of different composite materials

Course Content:

UNIT I INTRODUCTION 9

Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes

UNIT II VARIOUS TYPES OF COMPOSITES 9

Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites

UNIT III FABRICATION METHODS 9

Processing of Composite Materials: Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-transplant method, pltrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 9

Fabrication stresses/Residual stresses in FRP laminated composites- Co-efficient of Thermal Expansion (C.T.E.) – Modification of Hooke”s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E”s -Stress and Moment Resultants due cooling of the laminates during fabrication

UNIT V TESTING OF COMPOSITES 9

Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Use of different material to design composites
2. Use of different techniques to process different types of composites and know the limitations of each process
3. Use of Mathematical techniques to predict the macroscopic properties of different Laminates

Text Book(s):

1. Materials characterization, Vol. 10, ASM hand book
2. Mechanical Metallurgy by G. Dieter Mc-Graw Hill
3. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker

Reference Books:

Agarwal, B. D. and Broutman, L. J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
Halpin, J. C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
Hyer M. W., and Scott R White, "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
Issac M Daniel and OriIshai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2007.
MadhujitMukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004

22PME24	**OPERATION RESEARCH**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To provide knowledge and training in using optimization techniques under limited resources for the engineering and business problems.
2. To do things best under the given circumstances.

Course Content:

UNIT I LINEAR MODELS 9

The phase of an operation research study – Linear programming – Graphical method– Simplex algorithm – Duality formulation – Sensitivity analysis

UNIT II TRANSPORTATION MODELS AND NETWORK MODELS 9

Transportation Assignment Models –Traveling Salesman problem-Networks models – Shortest route – Minimal spanning tree – Maximum flow models –Project network – CPM and PERT networks – Critical path scheduling – Sequencing models.

UNIT III INVENTORY MODELS 9

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV QUEUEING MODELS 9

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation.

UNIT V DECISION MODELS 9

Decision models – Game theory – Two person zero sum games – Graphical solution- Algebraic solution– Linear Programming solution – Replacement models – Models based on service life- Economic life-Single /Multi variability search technique – Dynamic Programming

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Upon completion of this course, the students can ability to use the optimization techniques for use engineering and Business problems
2. Analyze any real time system with limited constraints and depict it in a model

Text Book(s):

1. Hillier and Libeber man, "Operations Research", Holden Day, 2005
2. Taha H.A., "Operations Research", Sixth Edition, Prentice Hall of India, 2003.

Reference Books:

1. Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley, 2009
2. Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.
3. Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992.
4. Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.
5. Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.

22OAG01 AGRICULTURAL FINANCE, BANKING AND CO-OPERATIVES

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To make the students aware about the agricultural Finance, Banking and Cooperation.
2. To acquaint the students with the basic concepts, principles and functions of management.
3. To understand the process of finance banking and cooperation

Course Content:

UNIT I AGRICULTURAL FINANCE - NATURE AND SCOPE 9

Agricultural Finance: Definition, Importance, Nature and Scope - Agricultural Credit: Meaning, Definition, Need and Classification - Sources of credit - Role of institutional and non - Institutional agencies: Advantages and Disadvantages - Rural indebtedness: consequences of rural indebtedness - History and Development of rural credit in India.

UNIT II FARM FINANCIAL ANALYSIS 9

Principles of Credit - 5C's, 5R's and & 7P's of Credit - Project Cycle and Management - Preparation of bankable projects / Farm credit proposals - Feasibility - Time value of money: Compounding and Discounting - Appraisal of farm credit proposals - Undiscounted and discounted measures - Repayment plans - Farm Financial Statements: Balance Sheet, Income Statement and Cash Flow statement - Financial Ratio Analysis.

UNIT III FINANCIAL INSTITUTIONS 9

Institutional Lending Agencies - Commercial banks: Nationalization, Agricultural Development Branches - Area Approach - Priority Sector Lending - Regional Rural Banks, Lead bank, Scale of finance - Higher financial institutions: RBI, NABARD, AFC, ADB, World Bank and Deposit Insurance and Credit Guarantee Corporation of India - Microfinance and its role in poverty alleviation - Self-Help Groups - Non -Governmental Organizations - Rural credit policies followed by State and Central Government - Subsidized farm credit, Differential Interest Rate (DIR), Kisan Credit Card (KCC) Scheme - Relief Measures and Loan Waiver Scheme and Know Your Customer (KYC).

UNIT IV CO-OPERATION 9

Co-operation: Philosophy and Principles - History of Indian Cooperative Credit Movement: Pre and Post-Independence periods and Cooperation in different plan periods - Cooperative credit institutions: Two tier and three tier structure, Functions: provision of short term and long term credit, Strength and weakness of cooperative credit system, Policies for revitalizing cooperative credit: Salient features of Vaithiyananthan Committee Report on revival of rural cooperative credit institutions, Reorganisation of Cooperative credit structure in Andhra Pradesh and single window system and successful cooperative credit systems in Gujarat, Maharashtra, Punjab etc, - Special cooperatives: LAMPS and FSS: Objectives, role and functions - National Cooperative Development Corporation (NCDC) and National Federation of State Cooperative Banks Ltd., (NAFSCOB) - Objectives and Functions.

UNIT V BANKING AND INSURANCE 9

Negotiable Instruments: Meaning, Importance and Types - Central Bank: RBI - functions – credit control - objectives and methods: CRR, SLR and Repo rate - Credit rationing - Dear money and cheap money - Financial inclusion and Exclusion: Credit widening and credit deepening monetary policies. Credit gap: Factors influencing credit gap - Non - Banking Financial Institutions (NBFI) - Assessment of crop losses, Determination of compensation - Crop insurance: Schemes, Coverage, Advantages and Limitations in implementation - Estimation of crop yields - Livestock, insurance schemes - Agricultural Insurance Company of India Ltd (AIC): Objectives and functions.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Be familiar with agricultural finance, Banking, cooperation and basic concepts, principles and functions of management.

Text Book(s):

1. Muniraj, R., 1987, Farm Finance for Development, Oxford & IBH, New Delhi
2. Subba Reddy. S and P.Raghu Ram 2011, Agricultural Finance and Management, Oxford & IBH, New Delhi.

Reference Books:

1. Lee W.F., M.D. Boehlje A.G., Nelson and W.G. Murray, 1998, Agricultural Finance, Kalyani Publishers, New Delhi.
2. Mammoria, C.B., and R.D. Saxena 1973, Cooperation in India, Kitab Mahal, Allahabad.

22OAG07 ENVIRONMENT AND AGRICULTURE

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

4. To emphasize on the importance of environment and agriculture on changing global scenario and the emerging issues connected to it.

Course Content:

UNIT I ENVIRONMENTAL CONCERNS 9

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems.

UNIT II ENVIRONMENTAL IMPACTS 9

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

UNIT III CLIMATE CHANGE 9

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

UNIT IV ECOLOGICAL DIVERSITY AND AGRICULTURE 9

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

UNIT V EMERGING ISSUES 9

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Students will appreciate the role of environment in the current practice of agriculture and concerns of sustainability, especially in the context of climate change and emerging global issues.
2. Ecological context of agriculture and its concerns will be understood

Text Book(s):

1. M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006.
2. Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005.

Reference Books:

3. T.C. Byerly, Environment and Agriculture, United States. Dept. of Agriculture. Economic Research Service, 2006.
4. Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century : proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994
5. Environment and agriculture: environmental problems affecting agriculture in the Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 1989

22OBT11	PRINCIPLES OF FOOD PROCESSING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To know about the constituents and additives present in the food.
2. To gain knowledge about the microorganisms, which spoil food and food borne diseases.
3. To know different techniques used for the preservation of foods.

Course Content:

UNIT I FOOD AND ENERGY 9

Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural Characteristics.

UNIT II FOOD ADDITIVES 9

Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.

UNIT III MICROORGANISMS ASSOCIATED WITH FOOD 9

Bacteria, yeasts and molds – sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.

UNIT IV FOOD BORNE DISEASES 9

Classification – food infections – bacterial and other types; food intoxications and poisonings – bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.

UNIT V FOOD PRESERVATION 9

Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Be aware of the different methods applied to preserving foods
2. Different constituents present in food and microorganism involved in processing of food.
3. Principles and different preservations techniques of food can also be known.
4. Unit operations in modern food processing and impact of the process on food quality
5. Discuss pulse processing and preservation techniques.
6. Explain spice processing and preservation techniques.
7. Identify oil seed processing and preservation.

Text Book(s):

1. T.P. Coultate – Food – The Chemistry Of Its Components, 2nd Edn. Royal Society,London,1992.
2. B. Sivasanker – Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. NewDelhi 2002.

Reference Books:

1. W.C. Frazier And D.C. Westhoff – Food Microbiology, 4th Ed., Mcgraw-Hill Book Co., NewYork 1988.
2. J.M. Jay – Modern Food Microbiology, Cbs Pub. New Delhi, 1987.

22OCS01	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS	L	T	P	C
		3	0	0	3

Pre-requisite Linear Algebra **Syllabus Version** V 0.1

Course Objectives:

1. To provide students with a fundamental understanding of Artificial Intelligence (AI) and Machine Learning (ML) concepts and techniques.
2. To equip students with the knowledge and skills necessary to develop basic machine learning models.
3. To enable students to apply these techniques in a variety of domains.

Course Content:

UNIT I INTRODUCTION TO AI AND MACHINE LEARNING 9

Definition and brief history of AI and machine learning - Types of machine learning: supervised, unsupervised, and reinforcement learning -The role of data in machine learning and the importance of data quality - Overview of the machine learning pipeline and common tools and frameworks used in machine learning.

UNIT II DATA PREPROCESSING FOR MACHINE LEARNING 9

Data cleaning and data normalization techniques - Handling missing values and outliers in data -Feature engineering and feature selection methods -Data visualization for exploratory data analysis.

UNIT III SUPERVISED LEARNING 9

Linear regression and logistic regression for regression and classification tasks, respectively - Decision trees and ensemble methods such as random forests and gradient boosting - Evaluation metrics for regression and classification models.

UNIT IV UNSUPERVISED LEARNING 9

Clustering algorithms such as k-means and hierarchical clustering - Principal component analysis (PCA) and other dimensionality reduction techniques - Anomaly detection and outlier analysis - Evaluation metrics for unsupervised learning algorithms.

UNIT V DEEP LEARNING AND NEURAL NETWORKS 9

Introduction to deep learning and neural networks - Convolutional neural networks (CNNs) for image classification and object detection - Recurrent neural networks (RNNs) for sequence modeling and natural language processing - Evaluation metrics for deep learning models.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Students will be able to define and explain the key concepts and terminologies in AI and ML.
2. Students will be able to prepare and preprocess data for machine learning models.
3. Students will be able to develop and evaluate basic machine learning models using supervised and unsupervised learning techniques.

4. Students will be able to implement deep learning models using neural networks for image classification and natural language processing tasks.
5. Students will be able to interpret and communicate the results of machine learning models.

Text Book(s):

3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems" by Aurélien Géron

Reference Books:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
2. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney
3. "Pattern Recognition and Machine Learning" by Christopher Bishop
4. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

22OCS13	**DATA STRUCTURES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the concepts of ADTs.
2. To learn linear data structures – lists, stacks, and queues.
3. To understand non-linear data structures – trees and graphs.
4. To understand sorting, searching and hashing algorithms.
5. To apply Tree and Graph structures

Course Content:

UNIT I LISTS 9

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists – Polynomial ADT Radix Sort – Multilists.

UNIT II STACKS AND QUEUES 9

Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions- Infixto Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues.

UNIT III TREES 9

Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVL Trees – Priority Queue (Heaps) – Binary Heap.

UNIT IV MULTIWAY SEARCH TREES AND GRAPHS 9

B-Tree – B+ Tree – Graph Definition – Representation of Graphs – Types of Graph - Breadth-first traversal – Depth-first traversal –– Bi-connectivity – Euler circuits – Topological Sort – Dijkstra's algorithm – Minimum Spanning Tree – Prim's algorithm – Kruskal's algorithm.

UNIT V SEARCHING, SORTING AND HASHING TECHNIQUES 9

Searching – Linear Search – Binary Search. Sorting – Bubble sort – Selection sort – Insertion sort – Shell sort –. Merge Sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing – Extendible Hashing.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define linear and non-linear data structures.
2. Implement linear and non–linear data structure operations.
3. Use appropriate linear/non–linear data structure operations for solving a given problem.
4. Apply appropriate graph algorithms for graph applications.
5. Analyze the various searching and sorting algorithms

Text Book(s):

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005.
2. Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2007

Reference Books:

1. Langsam, Augenstein and Tanenbaum, Data Structures Using C and C++, 2nd Edition, PearsonEducation, 2015.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, Introduction toAlgorithms", Fourth Edition, Mcgraw Hill/ MIT Press, 2022.
3. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft ,Data Structures and Algorithms, 1st edition,Pearson, 2002.
4. Kruse, Data Structures and Program Design in C, 2nd Edition, Pearson Education, 2006

22OCS14	**DATABASE MANAGEMENT SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn the fundamentals of data models and to represent a database system using ERdiagrams.
2. To study SQL and relational database design.
3. To understand the internal storage structures using different file and indexingtechniques which will help in physical DB design.
4. To understand the fundamental concepts of transaction processing-

concurrencycontrol techniques and recovery procedures.

5. To have an introductory knowledge about the Storage and Query processing Techniques

Course Content:

UNIT I RELATIONAL DATABASES 9

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases – Relational Model – Keys – Relational Algebra – SQL fundamentals – Advanced SQL features – Embedded SQL– Dynamic SQL.

UNIT II DATABASE DESIGN 9

Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – Functional Dependencies – Non-loss Decomposition – First, Second, Third Normal Forms, Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form – Join Dependencies and Fifth Normal Form.

UNIT III TRANSACTIONS 9

Transaction Concepts – ACID Properties – Schedules – Serializability – Concurrency Control – Need for Concurrency – Locking Protocols – Two Phase Locking – Deadlock – Transaction Recovery - Save Points – Isolation Levels – SQL Facilities for Concurrency and Recovery.

UNIT IV IMPLEMENTATION TECHNIQUES 9

RAID – File Organization – Organization of Records in Files – Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for SELECT and JOIN operations – Query optimization using Heuristics and Cost Estimation.

UNIT V ADVANCED TOPICS 9

Distributed Databases: Architecture, Data Storage, Transaction Processing – Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL, OQL - XML Databases: XML Hierarchical Model, DTD, XML Schema, XQuery – Information Retrieval: IR Concepts, Retrieval Models, Queries in IR systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Classify the modern and futuristic database applications based on size and complexity
2. Map ER model to Relational model to perform database design effectively
3. Write queries using normalization criteria and optimize queries
4. Compare and contrast various indexing strategies in different database systems
5. Appraise how advanced databases differ from traditional databases

Text Book(s):

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, SixthEdition, Tata McGraw Hill, 2011.
2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Sixth Edition, Pearson Education, 2011.

Reference Books:

1. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition,Pearson Education, 2006.
2. Raghu Ramakrishnan, ―Database Management Systems‖, Fourth Edition, McGraw-HillCollege Publications, 2015.
3. G.K.Gupta,"Database Management Systems”, Tata McGraw Hill, 2011

22OEC14	**INTRODUCTION TO MEMS AND NEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the concepts of micro and nano electromechanical devices
2. To know the fabrication process of Microsystems
3. To know the design concepts of micro sensors
4. To know the design concepts of micro actuators
5. To introduce the concepts of quantum mechanics and nano systems

Course Content:

UNIT I INTRODUCTION TO MEMS AND NEMS 9

Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES 9

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA

UNIT III MICRO SENSORS 9

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester

UNIT IV MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study:RF Switch

UNIT V NANO DEVICES 9

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Interpret the basics of micro/nano electromechanical systems including their applications and advantages
2. Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA
3. Analyze the key performance aspects of electromechanical transducers including sensors
4. Analyze the key performance aspects actuators
5. Comprehend the theoretical foundations of quantum mechanics and Nano systems

Text Book(s):

1. Marc Madou, —Fundamentals of Microfabrication, CRC press 1997.
2. Stephen D. Senturia, Micro system Design, Kluwer Academic Publishers,2001

Reference Books:

1. Tai Ran Hsu ,MEMS and Microsystems Design and Manufacture ,Tata Mcraw Hill, 2002.
2. Chang Liu, —Foundations of MEMS, Pearson education India limited, 2006,
3. Sergey Edward Lyshevski, —MEMS and NEMS: Systems, Devices, and Structures CRC Press, 2002

22OEC15	**IOT CONCEPTS AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Syllabus Version V 0.1

Course Objectives:

1.To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
2.To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
3. To introduce the technologies behind Internet of Things (IoT).
4. To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.

Course Content:

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

UNIT II COMPONENTS IN INTERNET OF THINGS 9

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 9

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV OPEN PLATFORMS AND PROGRAMMING 9

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT V IOT APPLICATIONS 9

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

Explain the concept of IoT.
Understand the communication models and various protocols for IoT.
Design portable IoT using Arduino/Raspberry Pi /open platform.
Apply data analytics and use cloud offerings related to IoT.
Analyze applications of IoT in real time scenario.

Text Book(s):

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

Reference Books:

1. Perry Lea, “Internet of things for architects”, Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
5. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.

22OEC19	Nano Technology and its Application	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To learn about basis of nanomaterial science, preparation method, types and application

Course Content:

UNIT I NTRODUCTION 9

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 9

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS 9

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Will familiarize about the science of nanomaterials
2. Will demonstrate the preparation of nanomaterials

3. Will develop knowledge in characteristic nanomaterial
4. Will develop knowledge in Application of nanomaterial

Text Book(s):

1. G Timp, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007.

Reference Books:

6. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
7. N John Dinardo, "Nanoscale Characterization of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

22OEC23	**Sensors and Actuators**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Syllabus Version V 0.1

Course Objectives:

1. Understand static and dynamic characteristics of measurement systems.
2. Study various types of sensors.
3. Study different types of actuators and their usage.
4. Study State-of-the-art digital and semiconductor sensors.

Course Content:

UNIT I INTRODUCTION TO MEASUREMENT SYSTEMS 9

Introduction to measurement systems: general concepts and terminology, measurement systems, sensor classification, general input-output configuration, methods of correction, performance characteristics: static and dynamic characteristics of measurement systems, zero-order, first order, and second-order measurement systems and response.

UNIT II RESISTIVE AND REACTIVE SENSORS 9

Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to LVDT.

UNIT III SELF-GENERATING SENSORS 9

Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers.

UNIT IV ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS 9

Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters.

UNIT V DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS 9

Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, MOSFET transistors, CCD imaging sensors , ultrasonic sensors, fiber-optic sensors.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Compare Actuators with various drive characteristics.
2. Evaluate digital sensors and semiconductor device sensors performance metrics.
3. Characterize the performance of Self-generating sensors.
4. Analyze the performance of self-generating Sensors.
5. Analyze the performance of resistive and reactive sensors.

Text Book(s):

1. Ian Sinclair, Sensors and Transducers, Elsevier, 3rd Edition, 2011.
2. D.Patranabis, “Sensors and Transducers”, TMH 2003.

Reference Books:

1. Andrzej M. Pawlak Sensors and Actuators in Mechatronics Design and Applications, 2006.
2. D. Johnson, “Process Control Instrumentation Technology”, 8th Ed, 2014, John Wiley and Sons.
3. Herman K.P. Neubrat, “Instrument Transducers – An Introduction to Their Performance and Design”, Oxford University Press. 22,1999.

22OME01	**ADDITIVE MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the development of Additive Manufacturing (AM), various business opportunities and applications.

2. To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3. To be acquainted with vat polymerization and direct energy deposition
4. To be familiar with powder bed fusion and material extrusion processes.
5. To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

Course Content:

UNIT I INTRODUCTION 9

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain-ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DFAM) 9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 9

Photo polymerization: Stereo lithography 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 IV POWDER BED FUSION AND MATERIAL EXTRUSION 9

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 9

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
2. Acquire knowledge on process of transforming a concept into the final product in AM technology

3. Elaborate the vat polymerization and direct energy deposition processes and its applications
4. Acquire knowledge on process and applications of powder bed fusion and material extrusion
5. Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

Text Book(s):

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

Reference Books:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521. 9780849334092.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011

22OME03	AIR POLLUTION AND CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce the students to the basics of air pollution, current air pollution issues, principles, concepts, methods adopted in the air quality management.
2. To provide an introduction to design principles and their applications in design of air pollution control system.

Course Content:

UNIT I INTRODUCTION 9

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards –Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

UNIT II METEOROLOGY 9

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

UNIT III CONTROL OF PARTICULATE CONTAMINANTS 9

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations.

UNIT IV CONTROL OF GASEOUS CONTAMINANTS 9

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations.

UNIT V INDOOR AIR QUALITY MANAGEMENT 9

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management.
2. Ability to identify, formulate and solve air and noise pollution problems
3. Ability to design stacks and particulate air pollution control devices to meet applicable standards.
4. Ability to select control equipment's

5. Ability to ensure quality, control and preventive measures.

Text Book(s):

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies‟ , Allied Publishers (P) Ltd., India 2002.

Reference Books:

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T. Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution", Tata Mcgraw Hill Publishing Company limited,2007.
5. C.S. Rao, "Environmental Pollution Control Engineering", New Age International(P) Limited Publishers, 2006.

22OME04	AUTOMOTIVE SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system

Course Content:

UNIT I AUTOMOTIVE ENGINE AUXILIARY SYSTEMS 9

Automotive engines- External combustion engines –Internal combustion engines - classification of engines- SI Engines- CI Engines- two stroke engines -four stroke engines construction and working principles - IC engine components- functions and materials -valve timing –port timing diagram- Injection system -Unit injector system- Rotary distributor type - Electronically controlled injection system for SI engines-CI engines-Ignition system - Electronic ignition system -Transistorized ignition system, capacitive discharge ignition system.

UNIT II VEHICLE FRAMES AND STEERING SYSTEM 9

Vehicle construction and different Chassis layouts –classifications of chassis- types of frames- frameless chassis construction –articulated vehicles- vehicle body - Vehicle aerodynamics-various resistances and its effects - steering system –conventional – sophisticated vehicle- and types of steering gear box-Power Steering- Steering geometry-

condition for true rolling motion-Ackermann's- Devi's steering system - types of stub axle – Types of rear axles.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints –- Hotchkiss Drive and Torque Tube Drive- rear axle- Differential-wheels and tyres.

UNIT IV SUSPENSION AND BRAKES SYSTEMS 9

Suspension Systems- conventional Suspension Systems -independent Suspension Systems –leaf spring – coil spring –taper-lite - eligo,s spring Types of brakes -Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control. Derive the equation of Forces acting while applying a brakes on plain surface - inclined road-gradient.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell. Turbo chargers -Engine emission control by three way catalytic converter system.

Note: Practical Training in dismantling and assembling of Engine parts and Transmission Systems should be given to the students.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the working concepts of ignition systems
2. Explain the arrangements of vehicles frame and steering systems.
3. Analyze the characteristics of clutch and gear box mechanisms.
4. Explain the components of suspension and types of braking systems.
5. Explain about the alternative energy sources and emission characteristics of SI and CI engines.

Text Book(s):

1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007.
2. Jain K.K. and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002.
3. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 1997.

Reference Books:

1. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
2. Joseph Heitner, "AutomotiveMechanics," Second Edition, East-West Press, 1999.

3. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart –Will Cox Company Inc, USA ,1978.
4. Newton ,Steeds andGaret, “Motor Vehicles”, Butterworth Publishers,1989.

22OME06	**CONCEPTS IN MOBILE ROBOTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To introduce mobile robotic technology and its types in detail.
2. To learn the kinematics of wheeled and legged robot.
3. To familiarize the intelligence into the mobile robots using various sensors.
4. To acquaint the localization strategies and mapping technique for mobile robot.
5. To aware the collaborative mobile robotics in task planning, navigation and intelligence.

Course Content:

UNIT I INTRODUCTION TO MOBILE ROBOTICS 9

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles

UNIT II KINEMATICS 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots

UNIT III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

UNIT IV LOCALIZATION 9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: At the end of the course the students would be able to
1.Evaluate the appropriate mobile robots for the desired application.
2.Analyze the sensors for the intelligence of mobile robotics
3. Evaluate the kinematics for given wheeled and legged robot.
the effect of alloying elements on ferrous and non-ferrous metals.
4.Create the localization strategies and mapping technique for mobile robot.
5.Crete the collaborative mobile robotics for planning, navigation and intelligence fordesiredapplications.

Text Book(s):

1.Roland Siegwart and IllahR.Nourbakish, "Introduction to Autonomous Mobile Robots" MITPress, Cambridge, 2004.

Reference Books:

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, "Humanoid Robots: Modelling andControl", Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, "Introduction to Mobile Robots Navigation", LAP LambertAcademic Publishing, 2015.
3. Peter Corke, "Robotics, Vision and Control", Springer, 2017.
4. Ulrich Nehmzow, "Mobile Robotics: A Practical Introduction", Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, "Mobile Robots - State of the Art in Land, Sea,Air, and Collaborative Missions", Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.

22OME08	**DIGITAL MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1.Students are able to understand the concept of digital manufacturing
2.Gather knowledge life cycle management and industrial iot application

Course Content:

UNIT I INTRODUCTION TO DIGITAL MANUFACTURING 9

Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System. Design process and role of CAD, Types and applications of design models. Component modeling, Machine and tool selection, Defining process and parameters, Tool path generation, Simulation, Post processing. : Introduction, Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, object quadra system-Rapid proto typing.

UNIT II DIGITAL FACTORY AND PRODUCT LIFE CYCLE MANAGEMENT 9

Introduction, Scope, Methods and Tools Used in Virtual Manufacturing, Benefits. Virtual factory simulation. Introduction, Types of Product Data, PLM systems, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

UNIT III INTERNET OF THINGS 9

Introduction, Applications, IoT data management requirements, Architecture of IoT, Technological challenges, RFID and the Electronic Product Code (EPC) network, The web of things, Issues in implementing IoT.

UNIT IV INDUSTRY 4.0 9

Definition of Industry 4.0, Comparison of Industry 4.0 Factory and today's Factory. Cybernetics as the scientific basis of cyber-physical models. Cybersecurity in Industry 4.0. Virtual models of process control. The application of robotics in the I4.0. Industrial internet of things. Intelligent process control and intelligent diagnostics. Cyber-Physical Systems, Cloud Computing / Cloud Manufacturing. BLOCK Chain- Value chains in manufacturing companies.

UNIT V INDUSTRIAL IOT- APPLICATION 9

Application Domains: Factories and Assembly Line, Food Industry. Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. Oil, chemical and pharmaceutical industry.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the students would be able to

1. Illustrate the Digital Manufacturing techniques with suitable applications.
2. Explain features of Digital Factory and PLM concepts.
3. Summarize the various features of IoT concepts.
4. Explain Industry 4.0 standards with relevance to industrial context.
5. Explain the intelligent systems in the Manufacturing environment.

Text Book(s):

1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer, 2004.
2. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013.

Reference Books:

1. “Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress)
2. “Industrial Internet of Things: Cyber manufacturing Systems” by Sabina Jeschke,
3. Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
4. Klaus Schwab 2016: The Fourth Industrial Revolution, Gerard Jounghyun Kim,
5. “Designing Virtual Systems: The Structured Approach”, Springer, 2005.

22OME11	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

Course Content:

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV 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, Excise Duty – Sales Tax.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures - Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the concepts of factors in Entrepreneurship.
2. Explain about the motivation training in Entrepreneurship.
3. Able to identify market survey
4. Understand the concepts of financial term in Entrepreneurship.
5. Gain knowledge and skills needed to run a business successfully.

Text Book(s):

1. Hisrich R D, Peters M P, “Entrepreneurship” 8 th Edition, Tata McGraw-Hill, 2013.
2. Mathew J Manimala, "Enterprenuership theory at cross roads: paradigms and praxis” 2 nd Edition Dream tech, 2005.
3. Rajeev Roy, "Entrepreneurship" 2 nd Edition, Oxford University Press, 2011.

Reference Books:

1. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 9 th Edition, Cengage Learning, 2014.
2. Khanka. S.S., “Entrepreneurial Development” S.Chand & Co. Ltd., Ram Nagar, New Delhi, 2013.

22OME12	**ENVIRONMENTAL AND SOCIAL IMPACT ASSESMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Define and Classify Environmental Impacts and the terminology
2. Understands the environmental Impact assessment procedure
3. Explain the EIA methodology
4. List and describe environmental audits

Course Content:

UNIT I INTRODUCTION 9

The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process.

UNIT II EIA METHODOLOGIES 9

Environmental attributes-Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods. EIA review- Baseline Conditions -Construction Stage Impacts, post project impacts.

UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9

EMP preparation, Monitoring Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, Monitoring Methods, Pre- Appraisal and Appraisal.

UNIT IV ENVIRONMENTAL LEGISLATION AND LIFE CYCLE ASSESSMENT 9

Environmental laws and protection acts, Constitutional provisions-powers and functions of Central and State government, The Environment (Protection) Act 1986, The Water Act 1974, The Air act 1981, Wild Life act 1972, Guidelines for control of noise, loss of biodiversity, solid and Hazardous waste management rules. Life cycle assessment: Life cycle analysis, Methodology, Management, Flow of materials-cost criteria- case studies.

UNIT V ENVIRONMENTAL IMPACT ASSESSMENT CASE STUDIES 9

Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Air ports.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1.Identify the environmental attributes to be considered for the EIA study
2.Formulate objectives of the EIA studies
3.Prepare environmental management plans
4.Identify the methodology to prepare rapid EIA
5.Prepare EIA reports

Text Book(s):

1. Anjaneyulu. Y and Manickam. V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002

Reference Books:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.

22OME13	**INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Understand the Industrial design process
2. Understand the various types of organization structures and their features, and their advantages and disadvantages, Financial Management.
3. Learning Principles of prototyping, economics Analysis & Prototype system.

Course Content:

UNIT I INDUSTRIAL AND MANUFACTURING DESIGN 9

Need for industrial design – Impact of industrial design – Industrial design process. Assessing the quality of industrial design- Human Engineering consideration -Estimate the manufacturing cost – Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM decisions on other factors

UNIT II INDUSTRIAL FINANCE MANAGEMENT 9

Investment decisions – Capital investment process, Type of investment proposals, Investment appraisal techniques – Payback period method, Accounting rate of return, Net present value method, Internal rate of return and Profitability index method.

UNIT III PROTOTYPING AND ECONOMIC ANALYSIS 9

Principles of prototyping – Planning for prototypes - Elements of economic analysis – Base case financial model – Sensitivity analysis – Influence of the quantitative factors

UNIT IV RAPID PROTOTYPING 9

Historical Development - Applications: Design, Planning, Manufacturing and Tooling, Automotive, Jewelry, Coin and Bio-Medical. Fundamentals of Rapid Prototyping, Design Process. Rapid Prototyping Process Chain

UNIT V RAPID PROTOTYPING SYSTEMS 9

Subsystems of RP machine - Optical System, Mechanical Scanning System, Computer Interfacing hardware, DAQs, Signal Flow, 3D Model to RP Prototype. Liquid Based Rapid Prototyping Systems, Solid Based Rapid Prototyping Systems, Powder Based Rapid Prototyping Systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Able to apply Industrial design process
2. To possess the principles and techniques of accounting and managing finance in an organization
3. Able to apply techniques for plant location, design plant layout and value analysis
4. Able to carry out work study to find the best prototype method for doing the work.
5. Able to study about rapid prototype systems.

Text Book(s):

1. Charles Gevirtz, Developing New products with TQM, McGraw – Hill International editions, 1994.
2. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW- HILL International Fifth Editions.2012.
3. James, C.Van Horne, “Fundamental of Financial Management”, Pearson education, 12th Edition, 2002.
4. Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.

5. Rapid Prototyping and Engineering applications: A tool box for prototype development, Liou W. Liou, Frank W. Liou, CRC Press, 2007

Reference Books:

1. Rosenthal.S, Effective product design and development, Irwin 1992.
2. Bhattacharya, S.K. and John Deardon, "Accounting for management – Text and Cases", Vikas Publishing house, New Delhi, 1996.
3. Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr

22OME25	**INDUSTRIAL IOT AND INDUSTRY 4.0**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand the fundamentals of Internet of Things
2. To learn about the basics of IOT protocols
3. To build a small low cost embedded system using IoT
4. To drive manufacturing forward.
5. To mitigate problems and provide solutions for enhancing our way of
6. Life through sustainable products and services.

Course Content:

UNIT I INTRODUCTION AND ARCHITECTURE OF IoT 9

Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT

UNIT II INDUSTRIAL IoT 9

IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

UNIT III IIOT ANALYTICS 9

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop

UNIT IV INDUSTRY 4.0 AND CYBER PHYSICAL SYSTEM 9

Introduction to Cyber Physical System (CPS), Architechture of CPS- Components, Data science and Technology for CPS, Emerging applications in CPS in different fields

UNIT V CASE STUDY 9

Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basic concepts and Architectures of Internet of Things.
2. Understand various IoT Layers and their relative importance.
3. Realize the importance of Data Analytics in IoT.
4. Implement the industry 4.0 to solve engineering problems.
5. Understand the concepts of Industry 4.0 and the other related fields.

Text Book(s):

1. Narendra jadhav., "New age Technology and Industrial Revolution 4.0", 5th edition 2019
2. I.A.Dhotre., "Industrial Internet of Things", 2nd edition 2022
3. Jeeva Jose,"Internet of Things", 1st edition 2021
4. Mr.Shivam Tiwari.,"Industry 4.0 supported by Machine learning", 1st edition 2022

Reference Books:

1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017
   2. "Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, HoubingS ong, Danda Rawat (Springer), 2017
2. Hands-On Industrial Internet of Things: Create a powerful Industrial
3. IoT by Giacomo Veneri, Antonio Capasso,Packt, 2018

22OME20	**LEAN SIX SIGMA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Explain the basics of Lean and Six Sigma.
2. Teach the need and the process of integrating Lean and Six sigma.
3. Summarize to identify and select the resources required for LSS Projects and selection of projects including Team building.
4. Teach the DMAIC process and study the various tools for undertaking LSS projects.
5. Illustrate to institutionalize the LSS efforts

Course Content:

UNIT I INTRODUCTION TO LEAN AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, Features of Lean; Top seven wastes, need for Lean management, the philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation

- Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, the structure of transforming event and Launch preparation.

UNIT III PROJECT SELECTION AND TEAM BUILDING 9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership

UNIT IV THE DMAIC PROCESS AND TOOLS 9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Cause and Effect matrix, Idea – generating and organizing tools – Brainstorming, Nominal group technique and Multi-voting; Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Set up time reduction (SMED) and the pull system; Control tools – statistical process control.

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS 9

Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand what is Lean and Six sigma and their importance in the globalized competitive world.
2. Understand the importance of integrating Lean and Six sigma and also the process of their integration
3. Plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams
4. Apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.
5. Understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

Text Book(s):

1. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2003
2. Michael L. George, Lean Six Sigma, McGraw-Hill., 2002

Reference Books:

1. Ronald G. Askin and Jeffrey B. Goldberg, Design and Analysis of Lean Production Systems, John Wiley &Sons., 2003.
2. Salman Taghizadegan, Essentials of Lean Six Sigma, Elsevier, 2010

22OME21	LOW COST AUTOMATION	L	T	P	C
		3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To give basic knowledge about automation
2. To understand the hydraulic circuit design in automation
3. To understand the Pneumatic circuit design in automation
4. To know the electronics system and PLS in automation
5. To enable the students to understand about industrial automation

Course Content:

UNIT I AUTOMATION OF ASSEMBLY LINES 9

Concept of automation - mechanization and automation - Concept of automation in industry - mechanization and automation - classification, balancing of assembly line using available algorithms - Transfer line-monitoring system (TLMS) using Line Status - Line efficiency - Buffer stock Simulation in assembly line

UNIT II AUTOMATION USING HYDRAULIC SYSTEMS 9

Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. - Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications.

UNIT III AUTOMATION USING PNEUMATIC SYSTEMS 9

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits

UNIT IV AUTOMATION USING ELECTRONIC SYSTEMS 9

Introduction - various sensors – transducers - signal processing - servo systems - programming of microprocessors using 8085 instruction - programmable logic controllers

UNIT V ASSEMBLY AUTOMATION 9

Types and configurations - Parts delivery at workstations - Various vibratory and non vibratory devices for feeding - hopper feeders, rotary disc feeder, centrifugal and orientation - Product design for automated assembly.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Comprehend the theoretical foundations of automation
2. Recognize the hydraulic circuit design in automation

3. Recognize the Pneumatic circuit design in automation
4. Address the representation of electronics system and PLS in automation
5. Learn different types of industrial automation

Text Book(s):

1. Anthony Esposito, “Fluid Power with applications”, Prentice Hall international, 2009.
2. Mikell P Groover, “Automation, Production System and Computer Integrated

Reference Books:

1. Kuo .B.C, “Automatic control systems”, Prentice Hall India, New Delhi, 2007.
2. Peter Rohner, “Industrial hydraulic control”, Wiley Edition, 1995.
3. Mujumdar.S.R, “Pneumatic System”, Tata McGraw Hill 2006.

22OME23	**MICRO AND PRECISION ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Learn about the macro and micro components.
2. To have an idea about the fabrication processes for micro-systems.
3. Understand handling and operating of the precision machine tools.
4. Learn to work with miniature models of existing machine tools/robots and other instruments.
5. Learn metrology for micro system.

Course Content:

UNIT I INTRODUCTION TO MICROSYSTEMS 9

Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.

UNIT II FABRICATION PROCESSES FOR MICRO-SYSTEMS: 9

Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and miniature biomedical devices

UNIT III INTRODUCTION TO PRECISION ENGINEERING 9

Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.

UNIT IV PRECISION MACHINING PROCESSES 9

Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes.

UNIT V METROLOGY FOR MICRO SYSTEMS 9

Metrology for micro systems - Surface integrity and its characterization.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Select suitable precision machine tools and operate
2. Apply the macro and micro components for fabrication of micro systems.
3. Apply suitable machining process
4. Able to work with miniature models of existing machine tools/robots and other instruments.
5. Apply metrology for micro system.

Text Book(s):

1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017

Reference Books:

1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
3. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.
4. Murthy.R.L, ―Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005

22OME25 PLANT LAYOUT AND MATERIAL HANDLING

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. Explain the basic principles in facilities planning and plant location
2. Interpret the basic principles in facility layout design decisions through proper analysis.
3. Illustrate and explain various techniques while designing a layout
4. Impart knowledge in line balancing concepts to implement improved system
5. Summarize the basic principles in designing, measuring and analyzing material flow to improve the efficiency of the system

Course Content:

UNIT I PLANT LOCATION 9

Plant location analysis – factors, costs, location decisions – Single facility location models, Multi facility location models - Mini-sum model - Mini-max model - Gravity location models, Brown & Gibbs model.

UNIT II FACILITIES LAYOUT 9

Facilities requirement, need for layout study – types of layout, Systematic layout planning, Relationship diagram, Designing the product layout – Line balancing - mixed model assembly line balancing.

UNIT III LAYOUT DESIGN 9

Designing the process layout - computerized layout planning procedure – ALDEP, CORELAP, CRAFT – Trends in computerized layout.

UNIT IV GROUP TECHNOLOGY 9

Group technology – OPTIZ classification system - Production Flow analysis (PFA), ROC (Rank Order Clustering).

UNIT V MATERIALS HANDLING 9

Principles, unit load concept, material handling system design, handling equipment types, selection and specification, containers and packaging.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Apply and evaluate appropriate location models for various facility types
2. Effectively design and analyze various facility layouts
3. Apply and analyze various computerized techniques while designing a layout
4. Effectively design and analyze a layout using grouping techniques
5. Implement smooth and cost effective system in the material handling process

Text Book(s):

1. James Apple, M.Plant layout and “Material Handling”, John Wiley, 1977.
2. Pannerselvam,R, “Production and Operations Management”, PHI,2017

Reference Books:

1. Richard Francis.L. and John A.White, “Facilities Layout and location - an analytical approach”, PHI., 2002
2. Tompkins, J.A. and J.A.White, “Facilities planning”, John Wiley, 2010.

22OME26 PROCESS MODELING AND SIMULATION

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To give an overview of various methods of process modeling, different computational techniques for simulation.

2. To train highly speacialized human resources.

Course Content:

UNIT I INTRODUCTION **9**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non- linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 9

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES 9

Numerical control (NC) machine tools - CNC: types, constitutional details, special features - design considerations of CNC machines for improving machining accuracy - structural members - slide ways - linear bearings - ball screws - spindle drives and feed drives. Part programming fundamentals - manual programming.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understood the development of process models based on conservation principles
2. To develop process data and computational techniques to solve the process models

Text Book(s):

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co., 1990

Reference Books:

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967

22OME27	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Pre-requisite **Nil** **Syllabus Version** **V 0.1**

Course Objectives:

1. To prepare students to excel in new product design and development through application of knowledge and practical skills II.
2. To provide students with a solid foundation in mathematical modeling of engineering problems required for bringing new products fast into the market III.
3. To provide students with required scientific and engineering knowledge so as to comprehend, analyze, design and create innovative products and solutions for real life problems

Course Content:

UNIT I INTRODUCTION 9

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

UNIT II CONCEPT GENERATION AND SELECTION 9

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology - benefits.

UNIT III PRODUCT ARCHITURE 9

Implications – Product change – variety – component standardization – product performance -manufacturability – product development management – establishing the architecture – creation -clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

UNIT IV PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS 9

Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT 9

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. The student will be able to design some products for the given set of applications.
2. The knowledge gained through prototyping technology will help the student to make a prototype of a problem.
3. The students will be able to design produc and development can be achieved.

Text Book(s):

1. Kari T.Ulrich and Steven D.Eppinger, Product Design and Development, McGraw-Hill International Edns. 1999

Reference Books:

1. Kemnneth Crow, Concurrent Engg./Integrated Product Development, DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, Effective Product Design and Development, Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, Tool Design -Integrated Methods for Successful Product Engineering, Addison Wesley Publishing, New york, NY

22OME28	**PRODUCTION AND OPERATION MANAGEMENT FOR ENTREPRENEURS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To know the basic concept and function of Production and Operation Management for entrepreneurship.
2. To understand the Production process and planning.
3. To understand the Production and Operations Management Control for business owners.

Course Content:

UNIT I INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research.

UNIT II PRODUCTION & OPERATION SYSTEMS 9

Production Systems- principles – Models - CAD and CAM- Automation in Production -

Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry.

UNIT III PRODUCTION & OPERATIONS PLANNING 9

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phaseAction phase- Control phase - Aggregate production planning.

UNIT IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation - Forecasting methods.

UNIT V CONTROLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control – Inventory control systems and techniques – JIT and Lean manufacturing – Network techniques – Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality – Control Chart (X , R , p , np and C chart) – Cost of Quality, Continuous improvement (Kaizen) – Quality awards – Supply Chain Management – Total Quality Management – 6 Sigma approach and Zero Defect Manufacturing.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. To understand the basics and functions of Production and Operation Management for business owners.
2. To learn about the Production & Operation Systems.
3. To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
4. To known about the Production & Operations Management Processes in organisations.
5. To comprehend the techniques of controlling, Production and Operations in industries

Text Book(s):

1. Carl Mcdaniel., “Business Management”, Re edition 2018
2. D.Eppinger., “Product Design and developmen”, 6th edition 2015
3. Solomon Geller., “Procuction Management”, Re edition 2022
4. S.Anil Kumar., “Production and Operations Management”, 2nd edition 2018
5. Jamid ul Islam., “Strategic Market Management”, 11th edition 2021

Reference Books:

1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.
2. Amitabh Raturi, Production and Inventory Management, , 2008.
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.
5. Chary S.N, Production and Operations Management, TMH Publications, 2010.

		L	T	P	C
22OME29	**PRODUCTION TECHNOLOGY OF AGRICULTURAL MACHINERY**	**3**	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To understand 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.
2. To understand the basic concepts of Computer Numerical Control (CNC) machine tool and CNC programming

Course Content:

UNIT I ENGINEERING MATERIALS 9

Engineering materials - their classification - Mechanical properties of materials, strength, elasticity, plasticity, stiffness, malleability, ductility, brittleness, toughness, hardness, resilience, machinability, formability, weldability. Steels and cast irons: Carbon steels, their classification based on percentage of carbon as low, mild, medium & high carbon steel, their properties & applications. Wrought iron, cast iron. Alloy steels: Stainless steel, tool steel.

UNIT II MACHINING 9

Basic principles of lathe - machine and operations performed on it. Basic description of machines and operations of Shaper-Planner, Drilling, Milling & Grinding.

UNIT III WELDING 9

Introduction, classification of welding processes. Gas welding, types of flames and their applications. Electric Arc welding. Resistance welding, Soldering & Brazing processes and their uses.

UNIT IV ADVANCED MANUFACTURING PROCESS 9

Abrasive flow machining - abrasive jet machining - water jet machining - Electro Discharge Machining (EDM) - Wire cut EDM - Electro Chemical Machining (ECM) - Ultrasonic Machining / Drilling (USM / USD) - Electron Beam Machining (EBM) - Laser Beam Machining (LBM).

UNIT V CNC MACHINE 9

Numerical control (NC) machine tools - CNC: types, constitutional details, special features - design considerations of CNC machines for improving machining accuracy - structural members - slide ways - linear bearings - ball screws - spindle drives and feed drives. Part programming fundamentals - manual programming.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Upon completion of this course, the students can able to apply the different manufacturing process and use this in industry for component production.
2. Ability to apply the knowledge of mathematics, and science and engineering in agriculture
3. Adility to design and conduct experiments, analyze and interpret data to prepare farm specific report.

Text Book(s):

1. "Manufacturing Engineering and Technology", Kalpakjian and Schmid, Pearson, 2010.
2. Hajra Choudry, "Elements of workshop technology - Vol II", Media promoters, 2002

Reference Books:

1. Gupta. K.N., and Kaushik, J.P., 1998, Workshop Technology Vol I and II, New Heights, Daryaganj, New Delhi.
2. Arthur. D., et. al. 1998, General Engineering Workshop Practice, Asia Publishing House, Bombay.
3. Chapman W.A.J., Workshop Technology, 1992, Part I, II, III, E.L.B.S. and Edward Amold Publishers Ltd, London.

22OME32	**RENEWABLE ENERGY SOURCES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To know the basic of renewable energy resources
2. To have an adequate knowledge about solar energy
3. To provide basic knowledge about wind energy systems, performance, site selection
4. To enhance the knowledge on bio energy
5. To have an adequate knowledge about Tidal energy, Wave Energy, OTEC, Hydro energy, Geothermal Energy, FuelCells and Hybrid Systems.

Course Content:

UNIT I INTRODUCTION RENEWABLE ENERGY RESOURCES 9

World Energy Use– Reserves of Energy Resources – Environmental Aspects of Energy Utilisation – Renewable Energy Scenario in Tamil nadu, India and around the – Economics of renewable energy systems.

UNIT II SOLAR ENERGY 9

Solar Radiation – Measurements of Solar Radiation - Flat Plate and Concentrating Collectors – Solar direct Thermal Applications – Solar thermal Power Generation - Fundamentals of Solar Photo Voltaic Conversion – Solar Cells – Solar PV Power Generation – Solar PV Applications.

UNIT III WIND ENERGY 9

Wind Data and Energy Estimation – Types of Wind Energy Systems – Performance – Site Selection – Details of Wind Turbine Generator – Safety and Environmental Aspects.

UNIT IV BIO - ENERGY 9

Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production– Bio diesel – Cogeneration - Biomass Application.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave Energy – Open and Closed OTEC Cycles – Small Hydro-Geothermal Energy – Hydrogen and Storage - Fuel Cell Systems – Hybrid Systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Discuss the importance and Economics of renewable Energy
2. Discuss the method of power generation from Solar Energy
3. Discuss the method of power generation from Wind Energy
4. Explain the method of power generation from Bio Energy
5. Explain the Tidal energy, Wave Energy, OTEC, Hydro energy, Geothermal Energy, Fuel Cells and Hybrid Systems.

Text Book(s):

1. Rai. G.D., "Non Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.
2. Twidell, J.W. & Weir, A., "Renewable Energy Sources", EFN Spon Ltd., UK, 2006.

Reference Books:

1. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
2. David M. Mousdale – "Introduction to Biofuels", CRC Press, Taylor & Francis Group, USA 2017
3. Freris. L.L., "Wind Energy Conversion Systems", Prentice Hall, UK, 1990.
4. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
5. Johnson Gary, L. "Wind Energy Systems", Prentice Hall, New York, 1985

22OME37 **VEHICLE STYLING AND DESIGN**

L	T	P	C
3	0	0	3

Pre-requisite Nil **Syllabus Version** V 0.1

Course Objectives:

1. To give basic knowledge about vehicle design
2. To understand the concept of vehicle body design
3. To understand the concepts of Noise and vibration in Vehicle
4. To know the knowledge of ergonomics in vehicle
5. To understand the knowledge of control systems in vehicle.

Course Content:

UNIT I INTRODUCTION TO VEHICLE DESIGN: 9

Timeline developments in design - Mass production – Streamlining for style and low drag - Commercial vehicles - Engine developments - Transmission system development – Steering – Suspension – Brakes - Interior refinement - Safety design.

UNIT II VEHICLE BODY DESIGN: 9

The styling process - Working environment and structure - Product planning - Concept sketching and package related sketching - Full sized tape drawing - Clay modelling.
Aerodynamics - Aerodynamic forces – Drag & Drag reduction - Stability during cross-winds – Wind Noise - Under-hood ventilation - Cabin ventilation - Introduction to Computational fluid dynamics - Wind tunnel testing of scale models.

UNIT III NOISE AND VIBRATION: 9

Vibration – fundamentals & control – Acoustics – fundamentals - Human response to sound - Sound measurement - Automotive noise criteria - Drive-by noise tests, Noise from stationary vehicles, Interior noise in vehicles, Automotive noise sources and control techniques – Engine noise, Transmission noise, Intake & exhaust noise, Aerodynamic noise, Tyre noise, Brake noise.

UNIT IV CRASHWORTHINESS AND ERGONOMIC APPROACH: 9

Accident and injury analysis - Vehicle impacts: general dynamics & crush characteristics - tructural collapse and its influence upon safety - Occupant accommodation – Ergonomics in the automotive industry - Ergonomics methods and tools - Case studies of Fiat Punto - Strategies for improving occupant accommodation and comfort.

UNIT V VEHICLE CONTROL SYSTEMS 9

Automotive application of sensors - Chassis control systems - Anti-lock braking systems, Traction control systems, Electronically controlled power-assisted steering - Vehicle safety and security systems - Air-bag and seat belt pre-tensioner systems, Remote keyless entry and vehicle immobilization, Introduction to On-board navigation systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Comprehend the theoretical information about vehicle design
2. Recognize the vehicle body design
3. Recognize the parameters of noise and vibration in vehicle
4. Understand the importance of Ergonomics concepts
5. Learn different types of vehicle control systems

Text Book(s):

1. An Introduction to Modern Vehicle Design, Julian Happian-Smith, Butterworth-Heinemann Ltd (2002)

Reference Books:

1. Aerodynamics of Road Vehicles: From Fluid Mechanics to Vehicle Engineering, Wolf-Heinrich Hucho (Eds.), Butterworth-Heinemann Ltd (1987)
2. Sensors and Transducers, Ian R Sinclair, Butterworth - Heinemann Ltd (2001)
3. The Motor Vehicle - T.K. Garrett, K. Newton & W. Steeds, Butterworth- Heinemann Ltd (2001)

22PME25	AUTOMOTIVE MATERIALS, COMPONENTS, DESIGNAND TESTING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

1. To study the functional requirements of engine components and suitable materials
2. To learn to design of cylinder and piston components
3. To learn to design of connecting rod and crank shaft
4. To learn to design of flywheel and valve train
5. To study the Engine Testing cycles, Emission measurement technologies

UNIT – I FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS 6

Functional requirements of engine components — Piston, piston pin, cylinder liner, connecting rod, crank shaft,valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.

UNIT – II DESIGN OF CYLINDER AND PISTON COMPONENTS 6

Design of cylinder, cylinder head, piston, piston rings and piston pin – more details in necessary

UNIT – III DESIGN OF CONNECTING ROD AND CRANK SHAFT 6

Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.

UNIT – IV DESIGN OF FLYWHEEL AND VALVE TRAIN 6

Design of valve – inlet valve – exhaust valve - Valve springs – tappet – rocker arm. Determination of mass of flywheelfor a given coefficient of fluctuation of speed. Design of flywheel - rim - hub - arm.

UNIT – V ENGINE TESTING 6

Engine test cycles – WLTC – WHSC – WHVC – NRTC – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. Emission measurement technologies and instruments - NOX – Smoke – Particulate matter– CO – CO2 - HC.-Particle counter

TOTAL=30 PERIODS

EXPERIMENTS

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft
3. Design flywheel and valve
4. Design and simulate Two Cylinder Engine assembly using CAD software.
5. Conduct the engine performance test using analysis software
6. Conduct the emission test using analysis software

TOTAL= 30 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Discuss the requirements of engine components and select suitable materials.
2. Apply the concept of design to cylinder and piston components and solve problems.
3. Apply the concept of design to Connecting rod and crank shaft and solve problems.
4. Apply the concept of design to flywheel and valve train and solve problems.
5. Discuss engine teste cycles, dynamometer and emission measurement technologies and instruments

TEXT BOOKS:

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. The Automotive Chassis: Volume 1: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019

REFERENCES:

1. Hiroshima Yamagata, "The science and technology of materials in automotive engines", Woodhead Publishing Limited, Cambridge, England
2. Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005.
3. Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
4. Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015
5. Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and ... Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010

22PME26	CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the advanced engine technologies
2. To learn various advanced combustion technologies and its benefits
3. To learn the methods of using low carbon fuels and its significance
4. To learn and understand the hybrid and electric vehicle configurations
5. To study the application of fuel cell technology in automotives

UNIT – I ADVANCED ENGINE TECHNOLOGY 9

Gasoline Direct Injection, Common Rail Direct Injection, Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, VVT, Intelligent Cylinder De-activation, After Treatment Technologies, Electric EGR, Current EMS architecture.

UNIT – II COMBUSTION TECHNOLOGY 9

Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.

UNIT – III LOW CARBON FUEL TECHNOLOGY 9

Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward

UNIT – IV HYBRID AND ELECTRIC VEHICLE (BATTERY POWERED) 9

Conventional Hybrids (Conventional ICE + Battery), Modern Hybrids (RCCI/GDCI Engine + Battery),Pure Electric Vehicle Technology — Challenges and Way forward

UNIT – V FUEL CELL TECHNOLOGY 9

Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboardhydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system
- Alkaline fuel cell - Road map to market.

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the latest trends in engine technology
2. Discuss the need of advanced combustion technologies and its impact on reducing carbonfoot-print on the environment.
3. Analyzing the basic characteristics of low carbon fuels, its impact over conventional fuels andin achieving sustainable development goals.
4. Discuss the working and energy flow in various hybrid and electric configurations.
5. Analyzing the need for fuel cell technology in automotive applications.

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric andFuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature CombustionEngines. ISBN 978-3-319-68507-6 , SPRINGER

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

22PME27	RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the low and zero carbon fuels suitability and methods of use in off-road vehicles.
2. To learn and understand the green energy production methodologies and its use in off-roadvehicle categories.
3. To learn various fuel cell types and its suitability in off-highway vehicles applications
4. To illustrate the impact of in-cylinder technologies on engine out emissions control.
5. To study the existing after-treatment technologies used in off-highway vehicle applications.

UNIT – I LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES 9

Ethanol, Methanol, Butanol, Biodiesel, CNG, LNG, DME, Polyoxymethylene Dimethyl Ether (PODE),Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.

UNIT – II GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES 9

Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.

UNIT – III FUEL CELL POWERED OFF-HIGHWAY VEHICLES 9

Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.

UNIT – IV IN-CYLINDER TREATMENT TECHNOLOGIES 9

Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed- Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies.

UNIT – V AFTER TREATMENT TECHNOLOGIES 9

Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO_2 absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Evaluate the availability, suitability, and its role in off-road vehicle categories in reducingthe carbon footprint on the environment.
2. Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.
3. Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.
4. Gain the knowledge on various in-cylinder low temperature combustion technologiesand its key role in controlling the engine-out emissions.
5. Develop the working of various existing aftertreatment systems in controlling the engineout emissions.

TEXT BOOKS:

1. John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015,
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature CombustionEngines.

REFERENCES:

1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology & Engineering,

2. W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control.
3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith andGordon Gill | 1 June 2011
4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport(Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. | 7 April 2022
5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite | 21 December 2017

22PME28	VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
2. To study the powertrain maintenance, fault diagnosis, maintenance of Batteries
3. To develop vehicle system maintenance and service of clutch, brake.
4. To study the concepts of vehicle safety and regulations.
5. To study and understand the simulation of safety concepts

UNIT – I INTRODUCTION 9

Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice- OBD and scantools;

UNIT – II POWERTRAIN MAINTENANCE 9

Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.

UNIT – III VEHICLE SYSTEM MAINTENANCE 9

Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, CheckingABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering

UNIT – IV VEHICLE SAFETY 9

Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steeringcolumn, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS,EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.

UNIT – V SIMULATION OF SAFETY CONCEPTS 9

Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exteriorsafety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. The students have the knowledge of vehicle health monitoring, maintenance and safety.
2. The students able to maintenance of powertrain.
3. The students can ability to maintenance of Vehicle system.
4. Explain and awareness of vehicle safety.
5. Explain the simulation of safety concepts.

TEXT BOOKS:

1. 5th Edition, “Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair” By Tom Denton
2. Safety Management System and Documentation Training Programme Handbook by S. V. PaulISBN: 9788123923444

REFERENCES:

1. Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition,2018
2. Bosch Automotive Handbook, Tenth Edition, 2018
3. Jack Erjavek, “A systems approach to Automotive Technology”, Cengage Learning, 5th Edition,2012
4. William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10thEdition,2004.
5. Vehicle Service Manuals of Reputed Indian Manufacturers.

22PME29	CAE AND CFD APPROACH IN FUTURE MOBILITY	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

1. To study the use of computer in mobility software or mobility.
2. To study the concepts computer aided design and rapid prototyping
3. To introduce the basic concepts of the finite elements methods.
4. To introduce basics and fundamental of the computational fluid dynamics
5. To introduce Turbulence Modelling and various simulation techniques.

UNIT – I INTRODUCTION TO CAE /CFD 6

Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modelling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering

UNIT – II CAD AND RAPID PROTOTYPING 6

Curves and Surfaces: Geometric modelling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Solid modelling: Fundamentals of solid modelling, Different solid representation schemes, Boundary representation (B-rep), Constructive solid geometry (CSG). Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modelling for RP, Surface modelling, STL file generation, Defects in STL files and repairing algorithms, Interface formats

UNIT – III INTRODUCTION TO FEA 6

Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using2D and 3D elements

UNIT – IV INTRODUCTION TO CFD 6

CFD vs. experimentation; continuity, navier-stokes and energy equations; modelling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method.Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks

UNIT – V PROBLEM SOLVING USING CFD 6

Turbulence Modelling, different turbulent modelling scheme. Incompressible Viscous Flows:, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation

TOTAL :30 PERIODS

CAE AND CFD LABORATORY

1. Coupled analysis of structural / thermal
2. buckling analysis
3. CFD simulation of flow analysis over a Cylinder Surface 3D
4. CFD simulation of Intermixing of Fluids in a Bent-Pipe 3D
5. CFD simulation of flow and heat transfer analysis of Double Pipe Counter FlowHeat Exchanger
6. Design & processing of Engine components by RPT

OUTCOMES: At the end of the course the students would be able to

1. discuss the basic concept of the CAE /CFD
2. Develop the computer aided design and rapid prototyping.
3. Discuss the basic concept of Finite Element methods.
4. discuss the concepts of computational fluid dynamics
5. solving the problem and simulation using computational fluid dynamics.

TEXT BOOKS:

1. Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh,Chaoqun Liu
2. Applied Computational Fluid Dynamics by S. C. Gupta

REFERENCES:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007
2. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education,2008
3. TirupathiR.Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
4. Dhanaraj. R and Prabhakaran Nair. K, "Finite Element Analysis", Oxford Publications, 2015.
5. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": Thefinite volume Method, Pearson Education, 2014
6. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill, 1998.

22PME30	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the concept of hybrid and electric drive trains.
2. To elaborate on the types and utilisation of hybrid and electric drive trains.
3. To expose on different types of AC and DC drives for electric vehicles.
4. To learn and utilise different types of energy storage systems
5. To introduce concept of energy management strategies and drive sizing

UNIT – I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics,History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT – II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept ofelectric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT – III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT – IV ENERGY STORAGE 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT – V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies,Implementation issues.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

TEXT BOOKS:

1. Iqbal Husain, ―Electric and Hybrid Vehicles: Design Fundamentals‖, Third Edition,2021
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

REFERENCES:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley &Sons, 1998
3. Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June2012
4. Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar |11 February 2011
5. Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December2013

22PME31	THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the working principle of Li-ion Batteries and Battery Packs.
2. To learn the thermal management system in Battery modules.
3. To develop the different case studies in Battery Thermal Management System.
4. To learn the working principle of Fuel Cells cooling methods.
5. To learn the inside components of Thermal Management Systems in various famousElectric and Fuel Cell Electric Vehicles.

UNIT – I ADVANCED BATTERIES 9

Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S- 18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Supercapacitors Vs batteries. Diamond battery concepts.

UNIT – II THERMAL MANAGEMENT IN BATTERIES 9

Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.

UNIT – III BATTERY THERMAL MANAGEMENT CASE STUDIES 9

EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modelling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multiphysics- simulation concepts.

UNIT – IV THERMAL MANAGEMENT IN FUEL CELLS 9

Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.

UNIT – V FUEL CELL THERMAL MANAGEMENT CASE STUDIES 9

Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the different Li-ion Batteries and Fuel Cell performances.
2. Design a Battery Pack with appropriate PCM.
3. Apply Cooling Models using Simulation
4. Estimate fuel economy.
5. Utilize different Thermal Management System approaches during real world usage.

TEXT BOOKS:

1. Ibrahim Dinçer, Halil S. Hamut, and Nader Javani, “Thermal Management of Electric VehicleBattery Systems’’, Wiley, 2017.
2. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesinElectric Drive Vehicles’’, Wiley, 2015.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric,and Fuel Cell Vehicles-Fundamentals, Theory, and Design’’, CRC Press, 2005.
4. John G. Hayes and G. Abas Goodarzi, “Electric Powertrain”, Wiley, 2018
5. Davide Andrea, “Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECHHouse, 2010.

REFERENCES:

1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, NewDelhi, 2013.
2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013,Coventry Techno centre, UK
3. Younes Shabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRCPress.
4. T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAEInternational.
5. Jerry Sergent, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, Mc Graw- Hill.

22PME32	VALUE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the value engineering process and able to identify its functions within the process.
2. To determine the appropriate value engineering methodology for a given project and propose appropriate training to centralized and decentralized modes.
3. To learn various decision-making processes and cost evaluation models and apply them in appropriately in the product development life-cycle.
4. To explore in-depth understanding of various value engineering applications in human resources, manufacturing and marketing.
5. To demonstrate to implement value engineering solutions and propose to perfect them.

UNIT – I VALUE ENGINEERING BASICS 9

Origin of value engineering - Meaning of value engineering - Definition of value engineering and Value analysis- Value Management - Value Analysis Versus Value Engineering - Value Analysis versus Traditional cost reduction techniques - Types of Value function — Basic and Secondary functions - concept of cost and worth - creativity In Value Engineering - uses, applications, advantages and limitations of Valueanalysis.

UNIT – II VALUE ENGINEERING JOB PLAN AND PROCESS 9

Seven phases of job plan - FAST Diagramming as Value Engineering Tool - Behavioral and organizational aspects of Value Engineering - Ten principles of Value analysis - Benefits of Value Engineering.

UNIT – III VALUE ENGINEERING TECHNIQUES 9

Creativity - Brain storming - Gordon technique - Morphological Analysis - ABC Analysis- Probabilistic approach - Make or Buy decisions — Function cost worth analysis (FCWA) - Function Analysis System technique (FAST) - Break Even Analysis - Life cycle cost(LCC)

UNIT – IV WORKSHEETS AND GUIDELINES 9

Preparation of worksheets - general and information phase - Function Classification, relationship and summary - Meaningful costs - Cost analysis - idea listing and comparison - Feasibility ranking - Investigator phase, study summary - guidelines for writing value engineering proposal - Financial aspects
- List cycle cost analysis - Oral presentation - Audit - Case studies and Discussion.

UNIT – V VERSATILITY OF VALUE ENGINEERING 9

Value engineering operation in maintenance and repair activities - value engineering in non hardware projects - Initiating a value engineering programme Introduction - training plan - career development for value engineering specialties.

Total :45 Periods

OUTCOMES: At the end of the course the students would be able to

1. Estimate a product cost based on value engineering principles in terms of its values, functions and worthiness.
2. Discuss the product and articulate it in various phases of value engineering
3. Discuss and select appropriate methods, standards and apply them on value engineeringproject and propose appropriate training
4. Apply querying theory and FAST to prefect a value engineering project implementation.
5. Develop various case studies related to value engineering project implementation.

TEXT BOOKS:

1. Iyer. S.S., “Value Engineering”, New Age International (P) Limited, 9th Edition, 2009 3Ed”, , 2009.
2. Anil Kumar. and Mukhopadhyaya., “Value Engineering: Concepts Techniques and applications”,SAGE Publications, 1st Edition, 2003.

REFERENCES:

1. Del L. Younker., “Value Engineering: analysis and methodology”, CRC Press, 2003.
2. Richard Park., “Value Engineering A Plan for Invention”, CRC Press, 1998.
3. Arthur E. Mudge., “Value Engineering :A systematic approach", McGraw Hill, 1989.
4. Alphonse Dell'Isola., “Value Engineering: Practical Applications...for Design, Construction, Maintenance and Operations”, R.S. Means Company, 1997.
5. Lawrence D. Miles., “Techniques of Value Analysis and Engineering”, Lawrence D. MilesValue Foundation, 3rd Edition, 2015.

22PME33	ADDITIVE MANUFACTURING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various businessopportunities and applications
- To familiarize various software tools, processes and techniques to create physical objectsthat satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes
- To be familiar with powder bed fusion and material extrusion processes.
- To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes

UNIT I INTRODUCTION 6

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions — Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM) 6

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation —Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION 6

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 IV POWDER BED FUSION AND MATERIAL EXTRUSION 6

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism -Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials
- Process - Advantages and Applications.

Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications andLimitations.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES 6

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations -Applications.

Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications.

Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing orAdhesive Bonding - Thermal Bonding- Materials-Application and Limitation.

TOTAL: 30 PERIODS

ADDITIVE MANUFACTURING LABORATORY

Experiments

1. Modelling and converting CAD models into STL file.
2. Manipulation and error fixing of STL file.
3. Design and fabrication of parts by varying part orientation and support structures.
4. Fabrication of parts with material extrusion AM process.
5. Fabrication of parts with vat polymerization AM process.
6. Design and fabrication of topology optimized parts.

TOTAL: 30 PERIODS

Equipment required - lab

1. Extrusion based AM machine
2. Resin based AM machine
3. Mechanical design software
4. Open-source AM software for STL editing, manipulation and slicing.

COURSE OUTCOMES:

At the end of this course students shall be able to:

CO1: Recognize the development of AM technology and how AM technology propagated intovarious businesses and developing opportunities.

CO2: Acquire knowledge on process of transforming a concept into the final product in AMtechnology.
CO3: Elaborate the vat polymerization and direct energy deposition processes and its applications. CO4: Acquire knowledge on process and applications of powder bed fusion and material extrusion.CO5: Evaluate the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturingtechnologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototypingand Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCES:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, RapidManufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press.,United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

22PME34	**CAD/CAM**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To Introduce and understand the Basic of Design.
2. To study the two dimensional drafting and bill of material creation.
3. To learn three dimensional modelling and its advantages.
4. To study the basic and purpose of assembling modeling.
5. To study the basics of computer aided machining and part programming.

UNIT – I BASICS OF DESIGNS 9

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Gridreading

UNIT – II 2D DRAFTING 9

Projection views – Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting

UNIT – III 3D MODELING 9

Conversion of Views – 2D to 3D & 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body In White) – Solid Modeling, Boolean operations like Unites, Subtraction, Intersect, etc.

UNIT – IV ASSEMBLY MODELING 9

Basics of Assembly modeling, Purpose of Assembly modeling & amp; its advantages – Top to Down & BottomUp modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis – Cumulative effect of Tolerances in after assembly conditions.- motion analysis

UNIT – V CAM 9

Basics of CNC Machining — 3, 4 & 5 Axis machines - CNC and Part Programing, CAM programing2D & 3D. Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation –Machining Stocks, Roughing, Re-roughing, Semi Finishing & Finishing - Tool Path Generation, Isl and Milling Programing. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. — Post Process NC Code conversion and Setup Sheet Preparation.

TOTAL : 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the basics of the design and concepts.
2. Develop the two dimensional drafting and projection views.
3. Discuss the three dimensional modeling, parametric and Non-parametric modeling
4. Discuss the assembly modeling and top down, bottom up approaches.
5. Develop the computer aided machining and wirting part programming.

TEXT BOOKS:

1. Computer Aided Design & Manufacturing - Jacob Moses & Ruchi Agarwal
2. CAD / CAM Principles & Application - J. Srinivas

REFERENCES:

1. CAD / CAM - Ibrahim Zaid (Text & Reference Book)
2. CAD / CAM – Chandandeep Grewal
3. CAD CAM & Automation - FarazdakHaideri (Text & Reference Book)
4. Computer Aided Design & Manufacturing – Anup Goel
5. CAD / CAM – PN Rao

22PME35	DESIGN FOR X	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.

2 To learn the design consideration principles of forming in the design of extruded, stamped, and forged products

3 To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.

4 To learn design consideration principles of welding in the design of welded products.

5 To learn design consideration principles in additive manufacturing

UNIT – I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances GeometricTolerances - Assembly limits -Datum features - Tolerance stacks.

Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT – II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice –Influence of materials on form design - form design of welded members, forgings and castings.

UNIT – III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Roboticassembly.

UNIT – IV COMPONENT DESIGN – CASTING CONSIDERATION 9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT – V DESIGN FOR ADDITIVE MANUFACTURING 9

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Elaborate the design principles for manufacturability
2. discuss the factors influencing in form design
3. Apply the component design features of various machine.
4. Discuss the design consideration principles of welding in the design of welded products.
5. Discuss the design consideration principles of additive manufacturing.

TEXT BOOKS:

1. James G. Bralla, “Design for Manufacturability Handbook”, McGraw Hill Professional, 1998.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts,Architectures and Implementation, Springer, 1998.

REFERENCES:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Designfor Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. ReasonPub., 1996.
5. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

22PME36 **ERGONOMICS IN DESIGN**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To introduce to industrial design based on ergonomics.
2. To consider ergonomics concept in manufacturing
3. To apply ergonomics in design of controls and display.
4. To apply environmental factors in ergonomics design.
5. To develop aesthetics applicable to manufacturing and product

UNIT – I INTRODUCTION 9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT – II ERGONOMICS AND PRODUCTION 9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics ofseeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT – III 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, Signaland 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 – IV ENVIRONMENTAL FACTORS 9

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation, reactions to colour and colour combination — colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT – V AESTHETIC CONCEPTS 9

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layoutdesign.

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product

TEXT BOOKS:

1. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) byMarcelo M. Soares , Francisco Rebelo
2. Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.

REFERENCES:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
3. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.

4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
5. Mayall W.H. “Industrial design for Engineers”, London Hiffee books Ltd., 1988.

22PME37	NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the fundamental concepts of the new product development
2. To develop material specifications, analysis and process.
3. To Learn the Feasibility Studies & reporting of new product development.
4. To study the New product qualification and Market Survey on similar products of new product development
5. To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

UNIT – I FUNDAMENTALS OF NPD 9

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis - Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud - QFD.

UNIT – II 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 – III 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 – IV CRITERIONS OF NPD 9

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness provingthrough X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing equencies. Market Survey on similar products, Risk analysis, validating samples with simulation results,Lesson Learned & Horizontal deployment in NPD.

UNIT – V REPORTING & FORWARD-THINKING OF NPD 9

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing — resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model — Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss fundamental concepts and customer specific requirements of the New Product development

2. Discuss the Material specification standards, analysis and fabrication, manufacturing process.
3. Develop Feasibility Studies & reporting of New Product development
4. Analyzing the New product qualification and Market Survey on similar products of new product development
5. Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar

22PME38	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To study about the history, concepts and terminology in PLM
2 To learn the functions and features of PLM/PDM
3 To develop different modules offered in commercial PLM/PDM tools
4 To demonstrate PLM/PDM approaches for industrial applications
5 To use PLM/PDM with legacy data bases, Coax& ERP systems

UNIT – I 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 – II PLM/PDM FUNCTIONS AND FEATURES 9

User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions — Communication and Notification, data transport, data translation, image services, system administration and application integration

UNIT – III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9

Case studies based on top few commercial PLM/PDM tools — Teamcenter, Windchill, ENOVIA, Aras PLM,SAP PLM, Arena, Oracle Agile PLM and Autodesk Vault.-Architecture of PLM software- selection criterion of software for particular application - Brand name to be removed

UNIT – IV ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance- process compliance and process automation

UNIT – V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLMand ERP

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Summarize the history, concepts and terminology of PLM
2. Develop the functions and features of PLM/PDM
3. Discuss different modules offered in commercial PLM/PDM tools.
4. Interpret the implement PLM/PDM approaches for industrial applications.
5. Integrate PLM/PDM with legacy data bases, CAx& ERP systems

TEXT BOOKS:

1. Product Lifecycle Management for a Global Market, Springer; 2014 edition (29 September 2016),ISBN-10 : 3662516330
2. Product Life Cycles and Product Management, Praeger Publishers Inc (27 March 1989)ISBN-10 : 0899303196

REFERENCES:

1. AnttiSaaksvuori and AnselmiImmonen, “Product Lifecycle Management”, Springer Publisher, 2008(3rd Edition)
2. IvicaCrnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, “Implementing and Integrating ProductData Management and Software Configuration Management”, Artech House Publishers, 2003.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”,Springer Publisher, 2011 (2nd Edition).
5. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

22PME39 SENSORS AND INSTRUMENTATION L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the concepts of measurement technology.
2. To learn the various sensors used to measure various physical parameters.
3. To learn the fundamentals of signal conditioning, data acquisition and communicationsystems used in mechatronics system development
4. To learn about the optical, pressure and temperature sensor
5. To understand the signal conditioning and DAQ systems

UNIT I INTRODUCTION 9

Basics of Measurement — Classification of errors — Error analysis — Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive,LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS 8

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magnetoresistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 10

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Recognize with various calibration techniques and signal types for sensors.

CO2: Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.

CO3: Apply the various sensors and transducers in various applicationsCO4:

Select the appropriate sensor for different applications.

CO5: Acquire the signals from different sensors using Data acquisition systems.

TEXT BOOKS:

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill,2009.
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCES

1. C. Sujatha ... Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons,Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRCPress, 2015.

22PME40 ELECTRICAL DRIVES AND ACTUATORS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor.

UNIT – I RELAY AND POWER SEMI-CONDUCTOR DEVICES 9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit
- Introduction to Driver and snubber circuits

UNIT – II DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection ofmotor.

UNIT – III DC MOTORS AND DRIVES 9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation — Applications

UNIT – IV AC MOTORS AND DRIVES 9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control
– Static rotor resistance control – Slip power recovery control.

UNIT – V STEPPER AND SERVO MOTOR 9

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation- Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor — Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

At the end of the course, the student able to:

CO 1: Recognize the principles and working of relays, drives and motors. CO 2:
Explain the working and characteristics of various drives and motors.
CO 3: Apply the solid state switching circuits to operate various types of Motors and DriversCO 4:
Interpret the performance of Motors and Drives.
CO 5: Suggest the Motors and Drivers for given applications.

TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand& Co.Ltd., New Delhi, 2016.

REFERENCES

1. Gobal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House,New Delhi, 2001.
2. Theraja B.L. &Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand&Co. Ltd., New Delhi, 2012.
3. Singh M.D. &Kanchandhani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

22PME41 EMBEDDED SYSTEMS AND PROGRAMMING

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills anddata exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT I INTRODUCTION TO MICROCONTROLLER 6

Fundamentals Functions of ALU - Microprocessor - Microcontrollers — CISC and RISC — Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets — Addressing Modes.

UNIT II PROGRAMMING AND COMMUNICATION 6

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I^2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III PERIPHERAL INTERFACING 6

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT IV ARM PROCESSOR 6

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT V SINGLE BOARD COMPUTERS AND PROGRAMMING 6

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages -– Python for Embedded Systems- GPIO Programming – Interfacing

TOTAL: 30 PERIODS

EMBEDDED SYSTEMS LAB

LIST OF EXPERIMENTS

1. Assembly Language Programming and Simulation of 8051.
2. Alphanumeric and Graphic LCD Interfacing using 8051 Microcontroller.
3. Input switches and keyboard interfacing of 8051.
4. Sensor Interfacing with ADC to 8051 and DAC & RTC Interfacing with 8051. .
5. Timer, Counter and Interrupt Program Application for 8051.
6. Step Motor (Unipolar & Bipolar Motor) and PWM Servo Motor Control to Interfacing with8051.
7. UART Serial and Parallel Port Programming of 8051.
8. I^2C, SPI and CAN Programming of 8051.
9. Interfacing and Programming of Bluetooth and Wi-Fi with 8051
10. Programming of ARM Processor for Sensor Interface.
11. Stepper Motor and Servo Motor Control Using ARM Processor.
12. Serial Communication of ARM Processor with Computation Platform.
13. Wireless Communication of ARM Processor with Computation Platform.
14. GPIO Programming of Real Time Embedded Operating Systems.
15. IOT application using SBC.

(any 7 experiments) **TOTAL: 30 PERIODS**

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO 1: Know the various functional units of microcontroller, processors and system-on-chipbased on the features and specifications.

CO 2: Recognize the role of each functional units in microcontroller, processors and system-on-chip based on the features and specifications.

CO 3: Interface the sensors, actuators and other I/O's with microcontroller, processors andsystem on chip based interfacing

CO4: Design the circuit and write the programming microcontroller, processors and systemon chip

CO 5: Develop the applications using Embedded system.

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

REFERENCES:

1. Muhammad Ali Mazidi and Janice GillispicMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with PythonMcGraw Hill TAB; 2nd edition,2015
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

22PME03	ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn about basics of robots and their classifications
2. To understand the robot kinematics in various planar mechanisms
3. To learn about the concepts in robot dynamics
4. To understand the concepts in trajectory planning and programming
5. To know about the various applications of robots

UNIT – I BASICS OF ROBOTICS 8

Introduction- Basic components of robot-Laws of robotics- classification of robot- robot architecture, work space-accuracy-resolution –repeatability of robot.

UNIT – II ROBOT KINMEATICS 11

Robot kinematics: Introduction- Matrix representation- rigid motion & homogeneous transformation- D-H, forward & inverse kinematics of 2DOF and 3 DOF planar and spatial mechanisms

UNIT – III ROBOT DYNAMICS 9

Introduction - Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation

UNIT – IV TRAJECTORY, PATH PLANNING AND PROGRAMMING 8

Trajectory Planning- Joint space and Cartesian space technique, Introduction to robot control, Robot programming and Languages- Introduction to ROS

UNIT – V ROBOT AND ROBOT APPLICATIONS 9

Sensors and Actuators for Robots, Power transmission systems, Rotary to rotary motion, Rotaryto linear motion, Harmonics drives — gear system - belt drives. Robot end effectors & Grippers: Introduction- types & classification- Mechanical gripper- gripper force analysis- other types & special purpose grippers. Robot Applications: pick and place, manufacturing, automotive, medical, space and underwater.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students can able to CO1:
State the basic concepts and terminologies of robots
CO2:Know the Procedures for Forward and Inverse Kinematics, Dynamics for Various RobotsCO3: Derive the Forward and Inverse Kinematics, Dynamics for Various Robots
CO4:Apply the various programming techniques in industrial applicationsCO5:
Analyze the use of various types of robots in different applications

TEXT BOOKS:

1. John.J.Craig, " Introduction to Robotics: Mechanics & control", Pearson Publication,Fourth edition, 2018.
2. K.S.Fu, R.C.Gonzalez, C.S.G.Lee, "Robotics: Sensing, Vision & Intelligence", TataMcGraw-Hill Publication, First Edition, 1987.

REFERENCES:

1. M.P.Groover, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Tata , McGraw-Hill Education Pvt Limited 2nd Edition, 2012.
2. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer, 2nd Edition, 2010
3. S K Saha, Introduction to Robotics, Tata McGraw-Hill, ISBN: 9789332902800, Second Edition, 9789332902800
4. Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.

22PME42 SMART MOBILITY AND INTELLIGENT VEHICLES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

The objectives of the course are:

1. To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
2. To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR SensorTechnology and Systems and other sensors for automobile vision system.
3. To learn Basic Control System Theory applied to Autonomous Automobiles.
4. To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
5. To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT – I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES 9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles

UNIT – II SENSOR TECHNOLOGY FOR SMART MOBILITY 9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion,Integration of Sensor Data to On-Board Control Systems

UNIT – III CONNECTED AUTONOMOUS VEHICLE 9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT – IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING 9

Wireless System Block Diagram and Overview of Components, Transmission Systems — Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking — the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks

UNIT – V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Recognize the concept of cyber-physical control systems and their application tocollision avoidance and autonomous vehicles

CO2: Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing

CO3: Familiar with the concept of fully autonomous vehicles

CO4: Apply the basic concepts of wireless communications and wireless data networks

CO 5: Analyze the concept of the connected vehicle and its role in automated vehicles

TEXT BOOKS

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer

REFERENCE:

1. Tom Denton, "Automobile Electrical and Electronic systems, Roultedge", Taylor & FrancisGroup,5th Edition,2018.

22PME43	HAPTICS AND IMMERSIVE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To learn various immersive technologies of VR, AR and MR.
2 To learn software related to immersive technologies.
3 To learn the concepts of developing AR applications.
4 To learn the concepts of developing VR and unreal engine.
5 To study the haptic perception and extended reality.

UNIT – I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9

Introduction on Virtual reality – Augmented reality – Mixed reality – Extended reality – VR Devices – AR Devices – Applications

UNIT – II SOFTWARE TOOLS 9

Intro to Unity – Unity editor workspace – Intro to C# and visual studio - Programming in Unity –Intro to Unreal Engine – UE4 Editor workspace – Intro to Blueprint programming – Programming in Ue4

UNIT – III BUILDING AR APPLICATION WITH UNITY 9

AR SDKs for unity and unreal engine – Working with SDKs for unity – Developing AR application in unity - Building AR application

UNIT – IV BUILDING VR APPLICATION WITH UNREAL ENGINE 9

VR SDKs for unity and unreal engine – Developing VR application in Ue4 – Building VR application

UNIT – V HAPTIC PERCEPTION AND EXTENDED REALITY 9

Extended Reality - Introduction to Haptics – Devices and possibilities – Custom Device development — Device Integration

TOTAL – 45 PERIODS

OUTCOMES: At the end of the course the students would be able to Apply

1. detailed knowledge about immersive technology Gaining the
2. knowledge of different types of Tools and DevicesAcquiring the
3. knowledge about Unity and Unreal Engine Explain the developing
4. application in immersive technologies Discuss about haptics in
5. immersive technologies

TEXT BOOKS:

1. Immersive Multimodal Interactive Presence, by Angelika Peer (Editor), Christos D. Giachritsis (Editor), Springer; 2012th edition (13 April 2014), ISBN-10 : 1447162137 XR Haptics,
2. Implementation & Design Guidelines, by Eric Vezzoli , Chris Ullrich , Gijs denButter , Rafal Pijewski, March 13, 2022

REFERENCES:

1. Practical Augmented Reality, by Steve Aukstakalnis, Addison-Wesley Professional; 1stedition (8 September 2016)
2. Augmented Reality - Theory, Design and Development, by Chetankumar G Shetty.
3. Strategic Communication and AI, by Simon Moore , Roland Hübscher, Routledge; 1stedition (10 September 2021), ISBN-10 : 0367627795
4. Immersive Analytics, by Kim Marriott , Falk Schreiber, Springer; 1st ed. 2018 edition (15October 2018).
5. Immersive Analytics A Clear and Concise Reference, by Gerardus Blokdyk, 5STARCooks(5 September 2018).

22PME04	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of drone concepts
2. To learn and understand the fundaments of design, fabrication and programming of drone
3. To impart the knowledge of an flying and operation of drone
4. To know about the various applications of drone
5. To understand the safety risks and guidelines of fly safely

UNIT – I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT – II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT – III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment-Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

UNIT – IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT – V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon successful completion of the course, students should be able to:

CO1: Know about a various type of drone technology, drone fabrication and programming. CO2: Execute the suitable operating procedures for functioning a drone

CO3: Select appropriate sensors and actuators for Drones CO4: Develop a drone mechanism for specific applications CO5: Create the programs for various drones

TEXT BOOKS

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016

REFERENCES

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016
2. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

22PME44	DIGITAL MANUFACTURING AND IoT	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

1 To study the various aspects of digital manufacturing.
2 To inculcate the importance of DM in Product Lifecycle Management and Supplychain Management.
3 To formulate of smart manufacturing systems in the digital work environment.
4 To interpret IoT to support the digital manufacturing.
5 To elaborate the significance of digital twin.

UNIT – I INTRODUCTION 6

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 – II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 6

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 – III SMART FACTORY 6

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 – IV INDUSTRY 4.0 6

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 – V STUDY OF DIGITAL TWIN 6

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 :30 PERIODS

DIGITAL MANUFACTURING AND IoT LABORATORY

Experiments

1. Measure the Distance Using Ultrasonic Sensor and Make Led Blink Using Arduino
2. Detect the Vibration of an Object Using Arduino
3. Sense a Finger When it is Placed on Board Using Arduino
4. Temperature Notification Using Arduino
5. Switch Light On and Off Based on the Input of User Using Raspberry Pi
6. Connect with the Available Wi-Fi Using Arduino

TOTAL : 30 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Impart knowledge to use various elements in the digital manufacturing.
2. Differentiate the concepts involved in digital product development life cycle processand supply chain management in digital environment.
3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyse and optimize various practical manufacturing process through digital twin.

TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of DigitalManufacturing 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 SmartManufacturing”, 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
4. Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”,Springer., Switzerland, 2018.
5. Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”,Springer., Switzerland, 2018.

2PME19	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the basics of 6 SIGMA
2. To learning about the lean manufacturing tools.
3. To study about the deeper understanding methodologies of Lean manufacturing.
4. To study the lean concepts and its elements.
5. To learn implementation and challenges of lean manufacturing.

UNIT – I BASICS OF 6 SIGMA 9

Introduction to 6 Sigma, basic tools of six sigma like problem solving approach, standard deviation, normal distribution, various sigma levels with some examples, value for the enterprise, Variation, and sources of variation, Mean and moving the mean, Various quality costs, cost of poor quality.

UNIT – II INTRODUCTION TO LEAN MANUFACTURING TOOLS 9

Process Capability Indices, Cause and Effect diagram, Control Charts, Introduction to FMEA, APQP, PPAP. 3 foundational 6 Sigma methodologies: DMAIC, DMEDI, and Process Management DMEDI for process creation, DMAIC for process improvement and PDCA for sustaining improvements.

UNIT – III DEEPER UNDERSTADING METHODOLOGIES 9

What is a process, Why Process management, Keys to process management, Difference between process management and 6 Sigma, Introduction to Deming cycle, PDCA, DMAIC and continuous improvement, DMEDI for creation process, DMAIC Vs DMEDI with examples, Introduction to Toyota Production System, Six Sigma and Production System integration.

UNIT – IV LEAN ELEMENTS 9

Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality, Delivery, Cost. Building Zero defect capabilities, Cultural and Organizational aspects

UNIT – V IMPLEMENTATION AND CHALLENGES 9

Implementing Checks and Balances in the process, Robust Information Systems, Dashboard, follow up and robust corrective and preventive mechanism. Concept of Audits, and continuous improvement from gap analysis, risk assessments etc.

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the basics of 6 SIGMA
2. Elaborate the lean manufacturing tools.
3. Illustrate about the deeper understanding methodologies of Lean manufacturing.
4. Discuss lean concepts and its elements.
5. Describe the implementation and challenges of lean manufacturing.

TEXT BOOKS:

1. Quality Planning and Analysis- JM Juran& FM Gryna. Tata Mc Graw Hill
2. Lean Manufacturing: Principles to Practice by Akhilesh N. Singh, Bibliophile SouthAsia
3. The Toyota Way: 14 Management Principles
4. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy,Masaki Imai

REFERENCES:

1. Quality Council of India https://qcin.org/ & its library. https://qcin.org/nbqp/knowledge_bank/
2. International Society of Six Sigma Professionals: https://isssp.org/about-us/

22PME45	MODERN ROBOTICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

1. To introduce definition, history of robotics and robot anatomy.
2. To learn the simulation of robot kinematics
3. To study the grasping and manipulation of robots.
4. To study about mobile robot and manipulation.
5. To study the applications of industrial, service, domestic robots.

UNIT – I INTRODUCTION 6

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.

UNIT – II SIMULATION OF ROBOT KINEMATICS 6

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Dennavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system.

UNIT – III GRASPING AND MANIPULATION OF ROBOTS 6

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.

UNIT – IV MOBILE ROBOTS 6

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forwardcontrol

UNIT – V APPLICATIONS OF ROBOTS 6

Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare

TOTAL :30 PERIODS

MODERN ROBOTICS LABORATORY

Experiments

1. 3D modeling and motion simulation of rotational joint assembly
2. 3D modeling and motion simulation of prismatic joint assembly
3. 3D modeling and motion simulation of Cartesian robot
4. 3D modeling and motion simulation of articulated robot
5. 3D modeling and motion simulation of spherical robot
6. 3D modeling and motion simulation of cylindrical robot

TOTAL :30 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the definition, history of robotics and robot anatomy.
2. Develop the simulation of robot kinematics
3. Describe the grasping and manipulation of robots.
4. Explain about mobile robot and manipulation.
5. Discuss the applications of industrial, service, domestic robots.

TEXT BOOKS:

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education(27 June 2019), ISBN-10 : 1641720751

REFERENCES:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019)ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma , Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN- 10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732

22PME46	**GREEN MANUFACTURING DESIGN AND PRACTICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To introduce the concept of environmental design and industrial ecology.
2. To impart knowledge about air pollution and its effects on the environment.
3. To enlighten the students with knowledge about noise and its effects on the environment.
4. To enlighten the students with knowledge about water pollution and its effects on the environment.
5. To introduce the concept of green co-rating and its need

UNIT – I DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT 9

Environmental effects of design -selection of natural friendly material - Eco design - Environmentaldamage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT – II AIR POLLUTION SAMPLING AND MEASUREMENT 9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation- the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dixide, carbon monoxide, oxidants and ozone.

UNIT – III NOISE POLLUTION AND CONTROL 9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise- Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT – IV WATER DEMAND AND WATER QUALITY 9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portableuse, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT – V GREEN CO-RATING 9

Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies Of Green Co- Rating

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the environmental design and selection of eco-friendly materials.
2. Analyse manufacturing processes towards minimization or prevention of air pollution.
3. Analyse manufacturing processes towards minimization or prevention of noise pollution.
4. Analyse manufacturing processes towards minimization or prevention of water pollution.
5. Evaluate green co-rating and its benefits.

TEXT BOOKS:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., NewDelhi, Second Edition, 2006

REFERENCES:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., NewDelhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, MarcelDecker, 1994.

22PME47	ENVIRONMENT SUSTAINABILITY AND IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To make the students to understand the concepts of Environmental Sustainability & Impact Assessment
2. To familiarize the students in environmental decision making procedure.
3. Make the students to identify, predict and evaluate the economic, environmental, and socialimpact of development activities
4. To provide information on the environmental consequences for decision making
5. To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

UNIT – I ENVIRONMENTAL IMPACT ASSESMENT 9

Environmental impact assessment objectives – rationale and historical development of EIA - Conceptualframeworks for EIA Legislative development – European community directive – Hungarian directive.

UNIT – II ENVIRONMENTAL DECISION MAKING 9

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and managementof environmental impacts- Socio economic impact assessment.

UNIT – III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION 9

Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change,uncertainty and risk.

UNIT – IV LIFE CYCLE ASSESSMENT 9

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

UNIT – V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT 9

Spatial economics – Knowledge economy and urban regions.

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the concepts of Environment Sustainability and trained to make decision related to Environment.
2. Make decision that has an effect on our environment
3. Evaluate the basics of environmental policy, planning and various legislation
   Get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.
4. Explain the Life cycle assessment of Environmental sustainability.
5. Explain sustainable urban economic development.

TEXT BOOKS:

1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, PeterDuinker , Tony R. Walker , Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194
2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1st editio(11 April 2022), ISBN-10 : 0367244470

REFERENCES:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development –Edward Elgar Publishing, 2007
2. Robort B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008
4. Canter, R.L., "Environmental Impact Assessment", McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., "Concepts In Environmental Impact Analysis", CommonWealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten "Environmental Impact Analysis Handbook", McGraw HillBook Company, 1990.

22PME48	ENERGY SAVING MACHINERY AND COMPONENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the various energy saving machineries and components to the studentsfor the purpose of conserving energy.
2. To study the basics and principles of transforms, Pumps and motors.
3. To impart the knowledge about the methods of energy conservation.
4. To introduce the energy efficiency devices and concepts of ENCON.
5. To impart the knowledge about CO2 mitigation.

UNIT – I BASICS OF ELECTRICAL ENERGY USAGE 9

Fuel to Power : Cascade Efficiency – Electricity Billing : Components and Costs – kVA – Need andControl – Determination of kVA demand and Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management (a brief) - energy monitoring, measurement and analysis.

UNIT – II TRANSFORMERS AND MOTORS 9

Transformer — Basics and Types — AVR and OLTC Concepts — Selection of Transformers — Performance Prediction - Energy Efficient Transformers - Motors : Specification and Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding and Over sizing - Energy Efficient Motors – ENCON Scope. Transmission Line Parameters – Transmission Line Losses- Kelvin's Law Performance Calculation and Analysis

UNIT – III FANS, PUMPS AND COMPRESSORS 9

Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods adopted for effecting ENCON – Economics of ENCON adoption.

UNIT – IV STUDY OF ILLUMINATION AND ENERGY EFFICIENT DEVICES 9

Specification of luminaries - Types - Efficacy - Selection and Application - ENCON Avenues and Economic Proposition - New Generation Luminaries (LED - Induction Lighting) - Soft Starters- Auto Star - Delta - Star Starters- APFC - Variable Speed and Frequency Drives - Time Sensors - Occupancy Sensors.

UNIT – V CO_2 MITIGATION AND CASE STUDIES 9

Evaluation for 3 / 4 Typical Sectors — PAT Scheme (an introduction) — CO_2 Mitigation - Energy Conservation - Cost Factor. Case Studies on Industrial Energy Audit.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the various energy saving machinery and components.
2. Evaluate the various methods of conservation of energy.
3. Evaluate the performance and energy conservation of fans, pumps and compressors.
4. Discuss the various energy efficiency devices.
5. Explain the co2 mitigation and cost factor.

TEXT BOOKS:

1. Energy-Efficient Shutdown of Circuit Components and Computing Systems, by Ehsan PakbazniProquest, Umi Dissertation Publishing (1 September 2011) ,ISBN-10 : 1243819898
2. Handbook on Energy Efficiency, TERI, New Delhi, 2001

REFERENCES:

1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management andCase Study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi,1997
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters, Kraushaar and Ristenen, Sustainable Energy, beta – test – draft, Energy and Problems of a Technical Society, 1993
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (www.energymanagertraining.com)
6. Nagrath IJ and Kothari DP, Power system engineering, TMH, 2007

22PME49	GREEN SUPPLY CHAIN MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To familiar the various standards and legislation of modern electronic manufacturing.
2. To know the conventional electronic processing and lead-free electronic manufacturing techniques.
3. To recognize the steps involved in assembly process and understand the need ofrecycle the electronics
4. To implement reliability and product life cycle estimation tools in green electronic manufacturing.
5. To demonstrate the green electronic manufacturing procedure in applications.

UNIT – I INTRODUCTION TO GREEN ELECTRONICS 9

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policyon green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT – II GREEN ELECTRONICS MATERIALS AND PRODUCTS 9

Basics of IC manufacturing and its process — Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

UNIT – III GREEN ELECTRONICS ASSEMBLY AND RECYCLING 9

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments
- Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

UNIT – IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN 9

Stages of product development process in green design: Materials- Manufacturing - Packaging anduse - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-designtools - Environmental management systems, and International standards - Eco-design in electronicsindustry.

UNIT – V CASE STUDIES 9

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management — Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Get concise awareness of standards and legislation of modern electronic manufacturingfor green environment.
2. Explain the conventional electronic processing and lead free electronic manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
4. Use reliability and product life cycle estimation tools for electronic manufacturing.
5. Validate the green electronic manufacturing procedures in applications.

TEXT BOOKS:

1. Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis ,Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

REFERENCES:

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on — Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, SpringerPublication., 2014.
4. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

22PME50	DESIGN OF PRESSURE VESSELS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the Mathematical knowledge to design pressure vessels and piping
2. To learn the ability to carry of stress analysis in pressure vessels and piping
3. To study the design of vessels and theory of reinforcement.
4. To study buckling and fracture analysis in vessels.
5. To learn piping layout and flow diagram.

UNIT – I INTRODUCTION 9

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

UNIT – II STRESSES IN PRESSURE VESSELS 9

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stressAnalysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT – III DESIGN OF VESSELS 9

Design of Tall cylindrical self-supporting process columns — Supports for short vertical vessels —Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circularhole, elliptical openings. Theory of Reinforcement — Pressure Vessel Design.

UNIT – IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS 9

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure –collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT – V PIPING 9

Introduction – Flow diagram – piping layout and piping stress Analysis.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain Methods for determining stresses Terminology and Ligament Efficiency, Applications
2. Analyse stress in pressure vessels
3. Design and analysis of pressure vessels.
4. Analysis of buckling and fracture analysis in vessels
5. Design and analysis piping layout and piping.

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors,1987.
2. Theory And Design Of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

REFERENCES:

1. Henry H. Bedner, “Pressure Vessels, Design Hand Book", CBS publishers and Distributors,1987.
2. Stanley, M. Wales, “Chemical process equipment, selection and Design". Buterworthsseries in Chemical Engineering, 1988.
3. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.
4. Sam Kannapan, “Introduction to Pipe Stress Analysis”. John Wiley and Sons, 1985.
5. Theory and design of Pressure Vessels (Pb 2001)by HARVEY J.F. | 1 January 2001

22PME51	FAILURE ANALYSIS AND NDT TECHNIQUES	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1. To introduce need and scope of failure analysis and fundamental sources of failures.
2. To learn about non-destructive testing and basic principles of visual inspection.
3. To study about magnetic testing and principles, techniques.
4. To learn the principle of radiography testing and its inspection techniques and methods.
5. To study the acoutistic testing principle and technique and instrumentation.

UNIT – I INTRODUCTION 9

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failureanalysis. Fundamental sources of failures. Deficient design. Improper Manufacturing & Assembly. Tree diagram and FMEA.

UNIT – II VISUAL INSPECTION 9

Introduction to Non-Destructive Testing: An Introduction, Visual examination, Basic Principle, The Eye, Optical aids used for visual inspection, Applications. Liquid Penetrant Testing: Physical principles, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, Sensitivity, Applications, Limitations and Standards

UNIT – III MAGNETIC TESTING 9

Magnetic Particle Testing, Eddy Current Testing: Magnetism-basic definitions and principle of. magnetic particle testing, Magnetizing techniques, induced current flow, Procedure used for testing a component, Equipment Used for magnetic particle testing, Sensitivity, Limitations. Eddy Current Testing: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced Eddy Current Test Methods, Applications, Limitations.

UNIT – IV RADIOGRAPHY TESTING 9

Radiography, Ultrasonic Testing: Basic principle, Electromagnetic radiation, Sources, Radiation attenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques, Applications of radiographic inspection, Limitations, Safety in Industrial Radiography, Standards, Neutron radiography. Ultrasonic Testing: Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle Beam Inspection, Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes of Display, Immersion Testing, Applications of Ultrasonic Testing, Advantages, Limitations

UNIT – V ACOUTISTIC TESTING 9

Acoustic Emission Testing: Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. Thermograph: Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. In Situ Metallographic Examination: Approach to theSelection of Site for Metallographic examination, Replication process, Significance of Microstructureobservation, Decision making, Applications, Codes and Standards.(digital signal process)

Total : 45 Periods

NON DESTRUCTIVE TESTING LABORATORY

Experiments

1. Conducting experiment using liquid penetrant testing
2. Conducting experiment using magnetic particle testing
3. Conducting experiment using ultrasonic testing
4. Conducting experiment using electromagnetic testing
5. Conducting experiment using acoutistic emission testing

Total :30 Periods

OUTCOMES: At the end of the course the students would be able to

1. Discuss the need and scope of failure analysis and fundamental sources of failures.
2. Describe about non-destructive testing and basic principles of visual inspection.
3. Explain about magnetic testing and principles, techniques.
4. Explain the principle of radiography testing and its inspection techniques and methods.
5. Describe the acoutistic testing principle and technique and instrumentation.

TEXT BOOKS:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age InternationalPublishers, 2010

REFERENCES:

1. ASM Metals Handbook,Non-Destructive Evaluation and Quality Control, American Societyof Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1,Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal TestingVol. 4,Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7,Ultrasonic Testing
3. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition NewJersey, 2005
5. J.Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, TataMcGraw-HillEducation, 2nd edition (2011).

22PME52	MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To provide knowledge on materials handling equipment.
2. To provide knowledge on Industrial Vehicles
3. To provide knowledge on conveyor equipment.
4. To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
5. To provide knowledge on Bulk Handling Equipment and Systems

UNIT – I INTRODUCTION TO MATERIALS HANDLING 9

Basic principles &objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments - unit load concept

UNIT – II INDUSTRIAL VEHICLES 9

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors - Industrial Tractor-Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory

UNIT – III CONVEYORS 9

Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors - Computer controlled conveyor system.

UNIT – IV AUXILIARY EQUIPMENTAND HOISTING EQUIPMENT 9

Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and unloaders -applications and advancements. - Hoisting Equipment - parts of hoistingequipment - Description and uses of hoists - Description and uses of ropes - description and purpose ofcrane hooks - Elevators - Cranes - Derricks - and its types

UNIT – V BULK HANDLING EQUIPMENT AND SYSTEMS 9

Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators -Robotic handling applications

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the basic concepts of material handling equipment.
2. Explain the basic working principles of various industrial Vehicles.
3. Develop the basic working principles of various conveyors.
4. Elabrate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.
5. Explain the basic working principles of various Bulk Handling Equipment and Systems.

TEXT BOOKS:

1. Allegri (Sr.), T.H., Material Handling — Principles and Practices, CBS Publishers and Distributors,Delhi, 1987.
2. Siddharta Ray, Introduction to Materials Handling, New Age International Publishers

REFERENCES:

1. Bolz, H. A and Hagemann, G. E (ed.), ''Materials Handling Handbook'', Ronald Press
2. 8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3. Apple, J.A., ''Material Handling System Design'', John Wiley & Sons
4. Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors
5. Immer J. R., Material Handling, Tata McGraw Hill Publication.

22PME53	ROTATING MACHINERY DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To familiarize the course member with various operations of gas turbines and other driven rotating machines.
2. To familiarize students with the common problems associated with the mechanical designand the lifting of the major rotating components of the gas turbine engine.
3. To study the failure criteria of rotating machinery.
4. To learn the design of discs, blades for rotating machinery.
5. To study about blade vibrations Damage Mechanisms.

UNIT – I INTRODUCTION 9

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms. Material, design and operational parameters that affect creep and fatigue. Experimental and test procedures to characterise creep and fatigue damage.

UNIT – II DESIGNING FORCES 9

Loads/forces/stresses in gas turbine engines: loads - rotational inertia, flight, precession of shafts, pressure gradient, torsion, seizure, blade release, engine mountings and bearings-Discussion of major loadings-rotating components and pressure casing components.

UNIT – III FAILURE CRITERIA 9

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failure mechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RM diagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factor for gas turbine components. Larson-Miller time-temperature parameter.

UNIT – IV BLADE DESIGN 9

Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades- simple desk-top method -effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue.

UNIT – V BLADE VIBRATIONS AND DAMAGE MECHANISMS 9

Natural frequencies turbomachine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Differentiate the operational regimes and requirements related to different gas turbine applications.
2. Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation;
3. Analyse, evaluate and assess the loads, stresses, failure criteria and factors of safety usedin gas turbine engines
4. Evaluate impact of vibrations on design and operation of gas turbine;
5. Assess the creep and fatigue damage of gas turbine components based on design and operational parameters

TEXT BOOKS:

1. A S Rangawala, Turbomachinery Dynamics-Design and operations, McGraw-Hill, 2005,ISBN-13: 978-0071453691.
2. Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN: 978-1-119-63169-9

REFERENCES:

1. P.P Walsh and P. Peletcher, Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
3. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
4. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
5. Shaft Alignment Handbook (Mechanical Engineering) by John Piotrowski | 2 November 2006

22PME54	THERMAL AND FIRED EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the concepts of thermal and fired equipment.
2. To study the basis, design and construction of boilers.
3. To study of typical fuel firing systems in the boiler.
4. To study of materials requirements for pressure parts.
5. To study of various boiler auxiliaries system.

UNIT – I INTRODUCTION 9

Principal equipment in Thermal Power Plant, Historical developments of Boiler, Utility, Industrial boilers,Morden trends in boiler design , Basic knowledge of different types of Thermal Fired Equipment ,sub critical and super critical boilers - Coal , Oil ,Gas , Pulverised fuel cyclone, FBC, CFBC , MSW , and Stoker firing, Boiler efficiency , auxiliary power consumption , Performance data , Performance Correction Curves

UNIT – II BASIS OF BOILERS AND DESIGN 9

Codes- Design and Construction, IBR, ISO, ASME, BS, Heat balance diagram, Boiler parameters, Fuelanalysis and variations, Site conditions, Furnace heat loadings, FOT, Plan area loading, Volumetric loading Balanced Draft and Pressurised Furnace, Natural / Controlled Circulation, Constant and Sliding Pressure, Boiler heat transfer surfaces, Flue gas velocities, boiler auxiliaries, Boiler schemes, Boiler Layouts

UNIT – III FIRING SYSTEM- FUEL AND MILLING 9

Coal / Oil / Natural Gas in any combination, Lignite, Blast Furnace Gas / Coke Oven Gas / Corex Gas Carbon Monoxide / Tail gas, Asphalt, Black Liquor, Bagasse, Rice Husk, Washery Rejects, Wheat / Rice straw MSW, wind box, Burner, Type of Stokers, Pulverisers - Bowl mill, Tube mill, Direct firing, Indirect firing, Wall firing (Turbulent / Vortex Burners), Tangential firing (Jet Burners), Fire Ball.

UNIT – IV PRESSURE PARTS AND DESIGN AND MATERIALS 9

Economiser, Drums , Water Walls , Headers , Links , Super Hater , Super Heaters , Reheaters, Tubes , Spiral Tubes , Surface area , Free Gas Area , Metal temperature , LMTD , Acid Due PointTemperature , Carbon steel , Low alloy steel , Titanium alloy steel

UNIT – V BOILER AUXILIARIES 9

Air preheaters (APH) – bi sector APH , Tri sector APH, Cold PA System, Hot PA System, Tubular APH,Steam coil Air preheater , FANS – Axial, Radial, Performance curves, MILLS- Tube , Vertical mills , Air quality Control systems ,DustCollection System - Mechanical Precipitator, Electrostatic Precipitator, FGD , SCR , SNCR

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the concepts of thermal and fired equipment.
2. Discuss the basis, design and construction of boilers.
3. Describe of typical fuel firing systems in the boiler.
4. Discuss the materials requirements for pressure parts.
5. Discuss of various boiler auxiliaries system.

TEXT BOOKS:

1. A Course in Power Plant Engineering; Dhanapat Rai and Sons - Domkundwar
2. Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar

REFERENCES:

1. Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964
2. Steam Generators and Waste Heat Boilers: For Process and Plant Engineers (Mechanical Engineering) by V. Ganapathy

22PME55	INDUSTRIAL LAYOUT DESIGN AND SAFETY	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the industrial facility layout design principles, process and material flow analysisand product and equipment analysis.
2. To learn the facilities layout design algorithms and selecting appropriate software.
3. To study the facilities layout problem modelling tools and algorithms for production,warehouse, and material handling.
4. To learn the safety planning and management principles in industries.
5. To learn the various safety management approaches in industries.

UNIT – I INTRODUCTION 6

Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach — Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs.

UNIT – II FACILITIES LAYOUT DESIGN & ALGORITHMS 6

Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design — Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP-PLANOPT, Factory CAD, Factory FLOW, Plant Simulation)

UNIT – III FACILITIES LAYOUT PROBLEM MODELS & ALGORITHMS 6

Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem,Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material-Handling System Design — Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation.

UNIT – IV SAFETY PLANNING & MANAGEMENT 6

Introduction: Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs: Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance: An Overview of an Accident, Occupational Health and Industrial Hygiene. Understanding the Risks: Prevention of Accidents Involving Hazardous Substances. Indian Factories Act 1948 for Health and Safety.

UNIT – V APPROACHES IN SAFETY MANAGEMENT 6

Safeguarding against Common Potential Hazards: Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures: Forklift Hazard Control, Tractor Hazard Control. Safe Handling and Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers.

TOTAL:30 PERIODS

INDUSTRIAL LAYOUT DESIGN LABORATORY

Experiments

1. Simulation of Manufacturing Shop
2. Simulation of Batch Production System
3. Simulation of Multi Machine Assignment System
4. Simulation of Manufacturing and Material Handling Systems
5. Simulation of a Shop Floor
6. Simulation of Material Handling Systems

TOTAL:30 PERIODS

COURSE OUTCOMES: At the end of the course the students would be able to

1. Explain the industrial facility layout design principles, process and material flow analysisand product and equipment analysis.
2. Discuss the facilities layout design algorithms and selecting appropriate software.
3. Describe the facilities layout problem modeling tools and algorithms for production, warehouse, and material handling.
4. Explain the safety planning and management principles in industries.
5. Illustrate the various safety management approaches in industries.

TEXT BOOKS:

1. Sunderesh S. Heragu, "Facilities Design", 3rd Edition, CRC Press Taylor & Francis Group,2008.
2. L. M. Deshmukh, "Industrial Safety Management: Hazard Identification and Risk Control",Tata McGraw-Hill Publishing Co. Ltd., 2005.

REFERENCES:

1. Eric Teicholz, "Facility Design and Management Handbook", Tata McGraw-Hill PublishingCo. Ltd., 2001.
2. James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco, "FacilitiesPlanning", 4th Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, "Manufacturing Facilities Design and Material Handling", 5th Edition, Purdue University Press, 2013.
4. Charles D.Reese, Occupational Health and Safety Management: A PracticalApproach, CRC Press, 2003.
5. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectivesof Asia, Springer, 2017.
6. Industrial Hazard and Safety Handbook: (Revised impressionby Ralph W King and JohnMagid | 24 September 2013

22PME56	DESIGN CODES AND STANDARDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the Codes and Standards and Need for them in the Industry
2. To know the different sources and the bodies that publish Codes and Standards
3. To familiarize the Government Regulations and its applicability
4. To familiarize with different codes used in Different Industry
5. To familiarize the Codes and Standards used in Process Industry

UNIT – I INTRODUCTION 9

Introduction to Codes and Standards. What is code? What is Standard?Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

UNIT – II CODES 9

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

UNIT – III STANDARDS 9

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardisation and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes.

UNIT – IV REGULATIONS 9

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

UNIT – V DESIGN CODES 9

Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish themand how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oiland Gas Industry.

TEXT BOOKS:

1. Mechanical Engg. Handbook. ASME. ASTM.API
2. Perrys Chemical Engg Handbook

REFERENCES:

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS
5. ISHRAE

22PME57	BIOENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To elucidate on biomass, types, availability, and characteristics
2. To study the bio-methanation process.
3. To impart knowledge on combustion of biofuels
4. To describe on the significance of equivalence ratio on thermochemical conversion of biomass
5. To provide insight to the possibilities of producing liquid fuels from biomass

UNIT – I INTRODUCTION 9

Biomass: types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies

UNIT – II BIOMETHANATION 9

Biomethenation process – influencing parameters – typical feed stocks – Biogas plants: types anddesign, Biogas appliances – burner, luminaries and power generation systems – Industrial effluentbased biogas plants.

UNIT – III COMBUSTION 9

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion

UNIT – IV GASIFICATION, PYROLYSIS AND CARBONISATION 9

Chemistry of gasification - types – comparison – typical application – performance evaluation – economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonisation

UNIT – V LIQUIFIED BIOFUELS 9

Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae -Process and chemistry - Biodiesel Vs. Diesel — comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Estimate the surplus biomass availability of any given area.
2. Design a biogas plant for a variety of biofuels.
3. Determine and compare the cost of steam generation from biofuels with that of coaland petroleum fuels.
4. Analyse the influence of process governing parameters in thermochemical conversionof biomass.
5. Synthesize liquid biofuels for power generation from biomass.

TEXT BOOKS:

1. Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar , SyedShams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550
2. Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel EshorameSanni , Solomon U. Oranusi, Springer (30 June 2022).

REFERENCES:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester,1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGrawHill, 1986

22PME58	CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce climate change and carbon footprint
2. To study the principle of product life cycle and Green House Gas emissions accounting
3. To study the Methodology for Carbon Footprint Calculation
4. To learn emission mitigation and carbon sink
5. To study the case study of carbon footprint.

UNIT – I CLIMATE CHANGE AND CARBON FOOTPRINT 9

Green House Effect and Climate Change - Causes and Impacts of Climate Change — Economic implications of Climate Change -IPCC Reports and Projected Climate Change Scenarios – GreenHouse Gas (GHG) Emission – Carbon footprint of Activities, Processes, Products and Services ofOrganisations — GHG Emission factors and Calculations

UNIT – II PRODUCT LIFE CYCLE AND GHG EMISSIONS 9

Life-cycle GHG Accounting - Principles of Product Life Cycle GHG Accounting and Reporting - Fundamentals of Product Life Cycle GHG Accounting - Establishing the Scope of a Product Inventory- GHG Emission Inventories and Accounting - Collecting Data and Assessing Data Quality- Allocation and Assessing Uncertainty

UNIT – III METHODOLOGICAL ASPECTS OF CARBON FOOTPRINT 9

Methodology for Carbon Footprint Calculation in Crop and Livestock Production, End of Life Scenarios and Carbon Footprint of Wood Cladding, Carbon Footprints and Greenhouse Gas Emission Savings of Alternative Synthetic Biofuels, Making Food Production GHG Efficient, Carbon Footprint of Wood-Based Products and Buildings, Challenges and Merits of Choosing Alternative Functional Units, modeling aspects of carbon footprint, Quantifying Spatial–Temporal Variability of Carbon Stocks and Fluxes

UNIT – IV EMISSION MITIGATION AND CARBON SINK 9

Setting GHG Reduction Targets and Tracking Inventory Changes – Non-Fossil Fuel based Energy Systems - Carbon Dioxide capture and Storage Technologies –Mitigation potentials of different Sectors and systems — Innovation, Technology Development and Transfer, - Social aspects of mitigation –Polcies, Institutions and international corporations – Carbon Pricing and Finance –GHG Offsetting and Green marketing.

UNIT – V CASE STUDIES 9

Carbon Footprint Estimation from Building Sector - Urban Carbon Footprint Evaluation - Applications of carbon footprint in urban planning — Mechanical Equipment and Electronic Product Carbon Footprint - Carbon Footprint of Aqua and Agriculture products- GHG Emissions from Municipal Wastewater Treatment and Solid waste management

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the climate change and carbon footprint
2. Discuss the principle of product life cycle and Green House Gas emissions accounting
3. Explain the Methodology for Carbon Footprint Calculation
4. Discuss emission mitigation and carbon sink
5. Explain the case study of carbon footprint.

TEXT BOOKS:

1. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1, by Subramanian Senthilkannan Muthu, Springer; Softcover reprint of the original 1st ed. 2014 edition (23 August 2016), ISBN-10 : 9811011737
2. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 2, by Subramanian Senthilkannan Muthu, Springer Nature; 2014th edition (30 April 2014), ISBN-10 : 9814585742

REFERENCES:

1. Subramanian, Senthil Kannan, Muthu (2016), Carbon Foot Print Handbook, CRC Press
2. Subramanian, Senthil Kannan, Muthu (2016), Environmental Carbon Foot Print Industrialcase Studies, Butterworth Heinemann Publishers
3. World Resources Institute, Green House Gas Protocol - Product Life Cycle Accounting and Reporting Standard
4. ISO 14067 -2018, Green House gases and carbon footprint, Requirements and Guidelinesfor Quantification, International Organisation for Standardisation.
5. IPCC (2022) –Sixth Assessment Reports – Intergovernmental Panel on Climate Change,United Framework convention on Climate Change.

22PME59	ENERGY CONSERVATION IN INDUSTRIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To learn Quantifying the energy demand and energy supply scenario of nation and explaining theneed for energy auditing for becoming environmentally benign
2. To Analyzing factors behind energy billing and applying the concept of demand side managementfor lowering energy costs
3. To learn Computing the stoichiometric air requirement for any given fuel and quantifying the energylosses associated with thermal utilities of industries
4. To Diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
5. To Applying CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project

UNIT – I INTRODUCTION 9

Energy scenario of World, India and TN - Environmental aspects of Energy Generation — Material and Energybalancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT – II ELECTRICAL SUPPLY SYSTEMS 9

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers — Harmonics

UNIT – III ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES 9

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters — Cooling Towers — D.G. sets. Insulation and Refractories - Waste HeatRecovery Devices.

UNIT – IV ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES 9

Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

UNIT – V ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS 9

Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling -Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept — PAT scheme

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the needfor energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

TEXT BOOKS:

1. Guide book for National Certification Examination for “Energy Managers and Energy Auditors” (4 Volumes). Available at http://www.em-ea.org/gbook1.asp. This website is administered by Bureau ofEnergy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and CaseStudies), Atlantic Publishers &Dist, 2007.

REFERENCES:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press,2006.
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7thEdition, The FairmontPress, 2013.
3. Murphy.W.R. and McKay.G, "Energy Management", Butterworth, London 1982.
4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.

22PME60	ENERGY EFFICIENT BUILDINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To learn the climate and buildings, building efficiency rating and standards
2. Developing energy efficiency in building envelopes through alternate methods
3. To study the thermal comfort, passive heating and cooling techniques
4. To apply various energy saving concepts in buildings.
5. To incorporate Renewable energy systems in buildings

UNIT – I INTRODUCTION 9

Climate and Building, Historical perspective, Aspects of Net Zero building design — Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards

UNIT – II LANDSCAPE AND BUILDING ENVELOPES 9

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools

UNIT – III THERMAL COMFORT, PASSIVE HEATING AND COOLING 9

Thermal comfort, Psychrometry, Comfort indices – ASHRAE / ISHRAE Standards on thermal Comfort – Passive heating and cooling systems - HVAC Systems for build environment – Heat Pumps, Evaporative Cooling and Radiant Cooling.

UNIT – IV ENERGY CONSERVATION IN BUILDING UTILITIES 9

Energy conservation in Hot water generator – Boiler, Heat Pumps, DG Sets, Motors , Pumps, IlluminationSystems, Electrical distribution systems, Cooling Towers,Refrigeration and Air Conditioning Systems, Water and Waste Management systems

UNIT – V RENEWABLE ENERGY IN BUILDINGS 9

Introduction of Renewable sources in buildings, , Stand-alone PV systems, BIPV, Solar water heating, Solar Air Conditioning in Buildings, Small wind turbines, Poly-generation systems in Buildings

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

TEXT BOOKS:

1. Advanced Decision Making for HVAC Engineers, by Javad Khazaii, Springer; Softcover reprintof the original 1st ed. 2016 edition (23 June 2018),ISBN-10 : 3319814869
2. Thermal Comfort and Energy-Efficient Cooling of Nonresidential Buildings, by Doreen E. Kalz,Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10 : 9783319045818.

REFERENCES:

1. ASHRAE Handbook – Fundamentals / Equipment's/ Applications – ASHRAE 2021,2020, 2019Editions
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley& Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design forEfficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

22PME22	ENERGY STORAGE DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the various types of energy storage devices and technologies and them comparison.
2. To learn the techniques of various energy storage devices and their performances.
3. To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
4. To learn about the renewable energy storage systems and management systems.
5. To have an insight into other energy storage devices, hydrogen, and fuel cells.

UNIT – I INTRODUCTION TO ENERGY STORAGE 9

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical–Thermal - Chemical– Electrochemical – Electrical - Other alternative energy storage technologies – Efficiency and Comparison.

UNIT – II ENERGY STORAGE SYSTEMS 9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent HeatStorage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

UNIT – III MOBILE AND HYBRID ENERGY STORAGE SYSTEMS 9

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

UNIT – IV RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT 9

Storage of Renewable Energy Systems –Solar Energy – Wind Energy – Energy Storage in Micro grid–Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management

UNIT – V OTHER ENERGY DEVICES 9

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC,SOFC,MCFC and Biofuel Cells – Biogas Storage.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

TEXT BOOKS:

1. Rober Huggins, “Energy Storage: Fundamentals, Materials and Applications”, 2 nd Edition,Springer, 2015.
2. Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001

REFERENCES:

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt,” Energy Storage in PowerSystems” Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, “Thermal Energy Storage Systems and Applications”, JohnWiley & amp; Sons, 2002.

22PME61	RENEWABLE ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To know the Indian and global energy scenario
2. To learn the various solar energy technologies and its applications.
3. To educate the various wind energy technologies.
4. To explore the various bio-energy technologies.
5. To study the ocean and geothermal technologies.

UNIT – I ENERGY SCENARIO 9

Indian energy scenario in various sectors — domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

UNIT – II SOLAR ENERGY 9

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT – III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

UNIT – IV BIO-ENERGY 9

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production -Applications.

UNIT – V OCEAN AND GEOTHERMAL ENERGY 9

Small hydro - Tidal energy — Wave energy — Open and closed OTEC Cycles — Limitations — Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the Indian and global energy scenario.
2. Describe the various solar energy technologies and its applications.
3. Explain the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Discuss the ocean and geothermal technologies.

TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall IndiaLearning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

REFERENCES:

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford UniversityPress, U.K., 2012.
2. Rai.G.D., “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.

22PME62	EQUIPMENT FOR POLLUTION CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the pollution control regulation and standards, water and wastewater.
2. To study the equipment for various water pollution.
3. To study the equipment for air pollution control.
4. To study the equipment for solid waste processing
5. To study the pollution monitoring equipment

UNIT – I POLLUTION CONTROL REGULATIONS AND STANDARDS 9

Pollutants in water and wastewater — sources and impacts- Characteristics and impacts of solid and hazardous wastes - Indian Constitution and Environmental Protection Legislations - Environmental Standards under different Environmental legislations - Water Act (1974), Air Act (1981), Environmental Protection Act (1986) and major Notifications, Municipal solid Wastes (Management and Handling) Rules - Bio Medical Wastes (Management and Handling) Rules - Hazardous Wastes (Management and Handling Rules),Environment Impact Assessment Notifications - Unit operations and unit processes in Pollution Control- - Selection criteria for Pollution Control Equipment.

UNIT – II EQUIPMENT FOR WATER POLLUTION CONTROL 9

Operational principles and Design criteria of Flash mixers, Flocculators, Clarifiers, Sand Filters, Adsorption Columns, Aerators, Air blowers, Distillation units, Centrifugal and Reciprocating Pumps, Chemical dosing systems, Motors, Pipes, valves and Fittings.- Filed visit to a wastewater treatment plant

UNIT – III EQUIPMENT FOR AIR POLLUTION CONTROL 9

Operational principles and Design criteria of Cyclone separators, gravity settlers, Wet Scrubbers, Airstrippers, Bag Filters, Electrostatic precipitators, Biofilters - Filed visit to an industry with air pollutioncontrol systems

UNIT – IV EQUIPMENT FOR SOLID WASTE PROCESSING 9

Operational principles and Design criteria of Dewatering equipment – centrifuge, Vaccum Filter, FilterPress- Size Reduction equipment – shredders, grinders – Trommel and Disc Screens – Air Classifiers
- bailing and briquetting – incinerators –Pyrolysis – field visit to a solid waste processing facility

UNIT – V POLLUTION MONITORING EQUIPMENT 9

Equipment's for sampling of water, solids and air- Sample preservation Equipment — incubators —Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gassampling and monitoring equipment

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the different types of pollution, their sources and effects.
2. Discuss the pollution control regulations and standards
3. Design equipment for pollution control
4. Discuss different methods of pollution control from various sources in air, water and soil
5. Discuss the Conduct performance assessment of pollution control equipment.

TEXT BOOKS:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid WasteManagement, Mc-Graw Hill India, First edition, 2015.
2. Rao. C.S (2006)., "Environmental Pollution and Control Engineering", 2nd Edition, Revised,Wiley Eastern Limited, India.

REFERENCES:

1. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2001
2. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.

22PME63	COMPUTATIONAL SOLID MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the definition and basics on theory of elasticity
2. To learn finite element method and procedure for static linear elasticity
3. To study the Non Linear and History depend problems
4. To study time dependent and dynamic problems of Small and large strain visco-plasticity
5. To study Structural Elements & Interfaces and contact using penalty method.

UNIT – I BASIC ON THEORY OF ELASTICITY 9

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain — displacement relations, Stress – strain relations, Lame's constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

UNIT – II FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY 9

Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variational forms; mixed methods. Accuracy and convergence; the Patch test.

UNIT – III NON LINEAR AND HISTORY DEPEND PROBLEMS 9

Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.

UNIT – IV TIME DEPENDENT AND DYNAMIC PROBLEMS 9

First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.

UNIT – V STRUCTURAL ELEMENTS & INTERFACES AND CONTACT 9

Continuum Beams — Shells — Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions)

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the definition and basics on theory of elasticity
2. Derive the finite element method for static linear elasticity, solve problems.
3. Discuss the Non Linear and History depend problems, Solve problems.
4. Discuss time dependent and dynamic problems, solve problems.
5. Discuss Structural Elements & Interfaces and contact, solve problems.

TEXT BOOKS:

1. L.S.Srinath, Advanced Mechanics Of Solids, 3rd Edition 2008.(0070139881 · 9780070139886).
2. J.N.Reddy, Introduction To Finite Element Method, 4th Edition 2020. (939038527X · 9789390385270).

REFERENCES:

1. The Mechanics of Solids and Structures - Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics)by Miguel Luiz Bucalem and Klaus- Jurgen Bathe | 25 February 2013
2. The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics)by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013

22PME64	COMPUTATIONAL FLUID DYNAMICSAND HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To study the fluid flow simulation techniques and its mathematical behaviour
2 To learn the Discretise 1D and 2D systems using finite difference and finite volume techniques
3 To Formulate diffusion –convection problems using finite volume method
4 To study the flow field for different types of grids
5 To learn the need for turbulence models and its types

UNIT – I INTRODUCTION 9

Basics of Computational Fluid Dynamics — Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison betweenAnalytical, Experimental and Numerical techniques, Techniques of Discretisation and Numerical errors

UNIT – II FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION 9

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems — Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nickolson, and pure implicit methods, stability of schemes.

UNIT – III FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion — Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.

UNIT – IV FLOW FIELD ANALYSIS 9

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid — Momentum equations, Pressure and Velocity corrections — Pressure Correction equation, SIMPLE algorithm and its variants — PISO Algorithms, Computation of internal and external thermal boundary layer.

UNIT – V TURBULENCE MODELLING 9

Turbulence model requirement and types, mixing length model, Two equation (k-Є) models — High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Apply the fundamentals of CFD, and develop case specific governing equations.
2. Discuss finite difference and finite volume based analysis for steady and transient diffusion problems.
3. Implement various mathematical schemes under finite volume method for convention diffusion.
4. Solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.
5. Apply the various discretization methods, solution procedure and the concept of turbulence modelling.

TEXT BOOKS:

1. Versteeg, H.K., and Malalasekera, W.,"An Introduction to Computational Fluid Dynamics": Thefinite volume Method, Pearson Education, 2014 .
2. Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning,2017.

REFERENCES:

1. John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.
2. K. Muralidhar & T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narora PublishingHouse, 1994.
3. Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor & Francis, 2009.
4. Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5. Yogesh Jaluria & Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002.

22PME65	THEORY ON COMPUTATION AND VISUALIZATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To study the concepts and techniques of discrete mathematics for theoretical computer science.
2 To learn different formal languages and their relationship.
3 To classify and construct grammars for different languages and vice-versa.
4 To study Visualization, Graphical and Quantitative Information.
5 To learn Visualization design and data Ink.

UNIT – I REVIEW OF MATHEMATICAL THEORY 9

Sets, Functions, Logical statements, Proofs, Relations, Languages, Principal of Mathematical Induction,Strong Principle, Recursive Definitions, Structural Induction.

UNIT – II REGULAR LANGUAGES AND FINITE AUTOMATA 9

Regular Expressions, Regular Languages, Application of Finite Automata, Automata with output — Moore machine & Mealy machine, Finite Automata, Memory requirement in a recognizer, Definitions, union- intersection and complement of regular languages, Non Deterministic Finite Automata, Conversion from NFA to FA, ??- Non Deterministic Finite Automata, Conversion of NFA- ? to NFA, Kleene's Theorem, Minimization of Finite automata, Regular And Non Regular Languages — pumping lemma.

UNIT – III CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA 9

Definitions and Examples, Unions Concatenations And Kleene's of Context free language, Regular Grammarfor Regular Language, Derivations and Ambiguity , Unambiguous CFG and Algebraic Expressions, BacosNaur Form (BNF), Normal Form — CNF. Definitions, Deterministic PDA, Equivalence of CFG and PDA & Conversion, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL.

UNIT – IV VALUE OF VISUALIZATION 9

Information Visualization, In Readings in Information Visualization, Graphical Excellence, Graphical Integrity, Sources of Graphical Integrity In The Visual Display of Quantitative Information

UNIT – V VISUALIZATION DESIGN 9

The Power of Representation, Data-Ink and Graphical Redesign, Data-Ink Maximization and GraphicalDesign, Data Density and Small Multiples

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discussing the concepts and techniques of discrete mathematics for theoretical computer science.
2. Explain the different formal languages and their relationship.
3. Discussing to classify and construct grammars for different languages and vice-versa.
4. Explaining the Visualization, Graphical and Quantitative Information.
5. Appling the Visualization design and data Ink.

TEXT BOOKS:

1. Introduction to the Theory of Computation by Michael Sipser
2. Automata Theory, Languages, and Computation By John Hopcroft, Rajeev Motowani, and JeffreyUllman

REFERENCES:

1. Introduction to Languages and the Theory of Computation, 4th by John Martin, Tata Mc Graw Hill
2. An introduction to automata theory and formal languages By Adesh K. Pandey, Publisher: S.K.Kataria& Sons
3. Introduction to computer theory By Deniel I. Cohen , Joh Wiley & Sons, Inc
4. Computation: Finite and Infinite By Marvin L. Minsky Prentice-Hall.

22PME66	COMPUTATIONAL BIO-MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To Introduction of principles and concepts of bio-mechanics.
2 Focuses on the studies of tissues and structure of musculoskeletal system.
3 To study the mechanics of joints and human motion.
4 To explain the computational approaches in biomechanics.
5 To learn the quantification of forces and motion.

UNIT – I INTRODUCTION TO BIOMECHANICS 9

Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles

UNIT – II BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM 9

Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves andSpinal Nerve Roots, Skeletal Muscle

UNIT – III BIOMECHANICS OF JOINTS AND HUMAN MOTION 9

Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linearkinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.

UNIT – IV COMPUTATIONAL APPROACHES IN BIOMECHANICS 9

Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture inFemur, Scaffolds, artificial hip and knee joints, Aortic Valve.

UNIT – V GAIT ANALYSIS 9

Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3Dprinting.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the principles of mechanics.
2. Elaborate the tissues and structures of the musculoskeletal system
3. Discuss of joint mechanics and human motion.
4. Create Examples of computational mathematical modelling applied in biomechanics.
5. Describe the analysis of human motion.

TEXT BOOKS:

1. Susan J Hall, —Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2. Jay D Humphrey and Sherry L Delange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010

REFERENCES:

1. Margareta Nordin and Victor H Frankel, —Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2. Ozkaya, Nihat, Nordin, and Margareta, —Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3. Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose , Advances in Computational Approaches in Biomechanics, 2022
4. Kinetics and Dynamics: From Nano- to Bio-Scale: 12 (Challenges and Advances in ComputationalChemistry and Physics)by Piotr Paneth and Agnieszka Dybala-Defratyka | 12 August 2010
5. Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) byGábor Náray-Szabó and Arieh Warshel | 31 March 2002

22PME67	ADVANCED STATISTICS AND DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To introduce the basic concepts of linear regression and multiple regression
2 To introduce exploratory data analysis
3 To study logistic regression models for classification
4 To develop the forecasting techniques for the predictions
5 To introduce the time series analysis for the prediction of future behavior

UNIT – I REGRESSION 9

Introduction — Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

UNIT – II EXPLORATORY DATA ANALYSIS 9

Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.

UNIT – III LOGISTIC AND MULTINOMIAL REGRESSION 9

Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient.

UNIT – IV FORECASTING AND CAUSAL MODELS 9

Moving average, Exponential Smoothing, Casual Models.

UNIT – V TIME SERIES ANALYSIS 9

Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Models

TOTAL 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Develop how to do regression fit for the given data.
2. Visualize the data through explanatory data analysis
3. Classify the given data through logistic regression
4. Analyzing forecasting techniques and causal inferences.
5. Utilize the effective time series analysis to predict/forecast the future behavior of data.

TEXT BOOKS:

1. Douglas C Montgomery and George C Runges, “Applied Statistics and Probability for Engineers”,John Wiley &Sons, 2014.
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, “Introduction to Time Series Analysisand Forecasting” ,Wiley,2015

REFERENCES:

1. David Forsyth, 'Probability and Statistics for Computer Science', Springer; 2018
2. Michael J. Evans, Jeffrey S. Rosenthal, 'Probability and Statistics - The Science of Uncertainty'. W HFreeman & Co, 2010
3. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer, 2014.
4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, "Probability and Statistics for Engineersand Scientists", Pearson Education, 2014.
5. Daniel T. Larose, Chantal D. Larose "Data Mining and Predictive Analytics", Wiley,2015
6. Thomas W.Miller, "Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science", Pearson Education, 2014.

22PME68	CAD AND CAE	L	T	P	C
		2	0	2	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Applying the fundamental concepts of computer graphics and its tools in a generic framework.
2. Creating and manipulating geometric models using curves, surfaces, and solids.
3. Applying concept of 3D modeling, visual realism,and CAD standard practices in engineeringdesign
4. Developing mathematical models for Boundary Value Problems and their numerical solution.
5. Formulating solution techniques to solve non-linear problems

UNIT – I FUNDAMENTALS OF COMPUTER GRAPHICS 6

Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics

UNIT – II GEOMETRIC MODELING 6

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling — Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

UNIT – III VISUAL REALISM and CAD STANDARDS 6

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducingefforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation.

Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.

UNIT – IV FINITE ELEMENT ANALYSIS 6

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

UNIT – V NON-LINEAR ANALYSIS 6

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate- Introduction to Analysis Software.

TOTAL:30 PERIODS

CAD & CAE LABORATORY

Experiments

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft using CAD software.
3. Design and simulate Two Cylinder Engine assembly using CAD software.
4. Coupled Simulation of structural /thermal analysis
5. Harmonic, Transient and spectrum analysis of simple systems.
6. buckling analysis

TOTAL:30 PERIODS

OUTCOMES: At the end of the course, the students would be able to

1. Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
2. Create and manipulate geometric models using curves, surfaces and solids.
3. Discuss concept of 3D modeling , visual realism and standard CAD practices in engineering design.
4. Develop the mathematical models for one dimensional finite element problems andtheir numerical solutions.
5. Formulate solution techniques to solve non-linear problems.

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007
2. Seshu.P, “Textbook of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 2012.

REFERENCES:

1. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw HillBook Co. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1992.
3. Foley, Wan Dam, Feiner and Hughes – “Computer graphics principles & practice”, Pearson Education - 2003
4. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann,2018.
5. Reddy,J.N. “Introduction to the Finite Element Method”, 4thEdition, Tata McGrawHill,2018.

22PME69	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce basic machine learning techniques such as regression, classification
2. To learn about introduction of clustering, types and segmentation methods
3. To learn about fuzzy logic, fuzzification and defuzzification
4. To learn about basics of neural networks and neuro fuzzy networks.
5. To learn about Recurrent neural networks and Reinforcement learning.

UNIT – I INTRODUCTION TO MACHINE LEARNING 9

Philosophy of learning in computers, Overview of different forms of learning, Classifications vs. Regression, Evaluation metrics and loss functions in Classification, Evaluation metrics and loss functions in Regression, Applications of AI in Robotics.

UNIT – II CLUSTERING AND SEGMENTATION METHODS 9

Introduction to clustering, Types of Clustering, Agglomerative clustering, K-means clustering, Mean Shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN Application case study, Principal component analysis (PCA), PCA Application case study in Feature Selection for Robot Guidance.

UNIT – III FUZZY LOGIC 9

Introduction to Fuzzy Sets, Classical and Fuzzy Sets, Overview of Classical Sets, Membership Function, Fuzzy rule generation, Fuzzy rule generation, Operations on Fuzzy Sets, Numerical examples, Fuzzy Arithmetic, Numerical examples, Fuzzy Logic, Fuzzification, Fuzzy Sets, Defuzzification, Application Case Study of Fuzzy Logic for Robotics Application

UNIT – IV NEURAL NETWORKS 9

Mathematical Models of Neurons, ANN architecture, Learning rules, Multi-layer Perceptrons, Back propagation, Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks, Application Case Study of Neural Networks in Robotics

UNIT – V RNN AND REINFORCEMENT LEARNING 9

Unfolding Computational Graphs, Recurrent neural networks, Application Case Study of recurrent networks in Robotics, Reinforcement learning, Examples for reinforcement learning, Markov decision process, Major components of RL, Q-learning. Application Case Study of reinforcement learning in Robotics

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Understand basic machine learning techniques such as regression, classification
2. Understand about clustering and segmentation
3. Model a fuzzy logic system with fuzzification and defuzzification
4. Understand the concepts of neural networks and neuro fuzzy networks.
5. Gain knowledge on Reinforcement learning.

TEXT BOOKS:

1. Micheal Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Addision Wesley, England, 2011

REFERENCES:

1. Bruno Siciliano, Oussama Khatib, “Handbook of Robotics”, 2016 2nd Edition, Springer
2. Simon Haykin, “Neural Networks and Learning Machines: A Comprehensive Foundation”, Third Edition, Pearson, delhi 2016.
3. Timothy J Ross, “Fuzzy Logic with Engineering Applications”, 4th Edition, Chichester,2011, Sussex Wiley.

22PME01	AUTOMOBILE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the construction and working principle of various parts of an automobile.
2. To study the practice for assembling and dismantling of engine parts and transmission system
3. To study various transmission systems of automobile.
4. To study about steering, brakes and suspension systems
5. To study alternative energy sources

UNIT – I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines — components-functions and materials, variable valve timing (VVT).

UNIT – II 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), Turbo chargers (WGT, VGT), Engine emission control by three way catalytic converter system, Emission norms (Euro and BS).

UNIT – III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, Overdrive, transferbox, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT – IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS),electronicbrake force distribution (EBD) and Traction Control.

UNIT – V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles, Fuel Cell Note: Practical Training in dismantling andassembling of Engine parts and Transmission Systems should be given to the students.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Recognize the various parts of the automobile and their functions and materials.
2. Discuss the engine auxiliary systems and engine emission control.
3. Distinguish the working of different types of transmission systems.
4. Explain the Steering, Brakes and Suspension Systems.
5. Predict possible alternate sources of energy for IC Engines.

TEXT BOOKS:

1. Jain K.K. and Asthana .R.B, “Automobile Engineering” Tata McGraw Hill Publishers, New Delhi, 2002.

2. Kirpal Singh, “Automobile Engineering”, Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi,13th Edition 2014.

REFERENCES:

1. Ganesan V. “Internal Combustion Engines”, Third Edition, Tata McGraw-Hill, 2012.
2. Heinz Heisler, “Advanced Engine Technology,” SAE International Publications USA, 1998.
3. Joseph Heitner, “Automotive Mechanics,” Second Edition, East-West Press, 1999.
4. Martin W, Stockel and Martin T Stockle , “Automotive Mechanics Fundamentals,” The Good heart - WillCox Company Inc, USA ,1978.
5. Newton, Steeds and Garet, “Motor Vehicles”, Butterworth Publishers,1989.

22PME70	MEASUREMENTS AND CONTROLS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To Identify measurement parameters and analyze errors of measurements.
2 To Select and apply suitable transducer for a particular measurement.
3 To identify measurement parameters and select the appropriate sensor for it.
4 To Explain the working of various types of control systems of apply for specific applications.
5 To apply the principle of automatic control systems to control various parameter(s).

UNIT – I MEASUREMENTS AND ERROR ANALYSIS 9

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty.

UNIT – II INSTRUMENTS 9

Transducer, modifying (intermediate) and Terminal stages – Mechanical and electrical transducers, preamplifiers – charge amplifiers – filters – attenuators – D' Arsonval – CRO – Oscillographs – recorders – microprocessor-based data logging, processing and output

UNIT – III PARAMETERS FOR MEASUREMENT 9

Dimension, displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

UNIT – IV CONTROL SYSTEMS 9

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements –Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical,magnetic, electronic control systems

UNIT – V APPLICATION OF CONTROL SYSTEMS 9

Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control –photo electric controls – designing of measurement and control systems for different applications

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Identify measurement parameters and analyze errors of measurements.
2. Select and apply suitable transducer for a particular measurement.
3. Identify measurement parameters and select the appropriate sensor for it.
4. Explain the working of various types of control systems of apply for specific applications.
5. Apply the principle of automatic control systems to control various parameter(s).

TEXT BOOKS:

1. Venkateshan S P, Mechanical Measurements, 2ndEdition, John Wiley & Sons, Ltd, 2015.
2. William Bolton, Instrumentation and Control Systems, 2ndEdition, Newnes, 2015.

REFERENCES:

1. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2013.
2. Ernest Doebelin and DhaneshManik, Measurement Systems, McGraw Hill InternationalEdition, 2017.
3. Holman J P, "Experimental Methods for Engineers", McGraw Hill Int. Edition, 7th Ed., 2017.
4. Nagrath I J, "Control Systems Engineering", New Age International Publishers, 2018.
5. NakraB.C , and Chaudhry K.K, Instrumentation, Measurement, and Analysis, Tata McGraw Hill, 4thEdition, 2016.

22PME71	DESIGN CONCEPTS IN ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the various design requirements and get acquainted with the processes involvedin product development.
2. To study the design processes to develop a successful product.
3. To learn scientific approaches to provide design solutions.
4. Designing solution through relate the human needs and provide a solution.
5. To study the principles of material selection, costing and manufacturing in design.

UNIT – I DESIGN TERMINOLOGY 9

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT – II INTRODUCTION TO DESIGN PROCESSES 9

Basic modules in design process-scientific method and design method-Need identification, importance ofproblem definition-structured problem, real life problem- information gathering -customer requirements- Quality Function Deployment (QFD)- product design specifications-generation of alternative solutions- Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation

UNIT – III CREATIVITY IN DESIGN 9

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks-Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map-Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

UNIT – IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT 9

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmentalaspects-marketing aspects-team aspects-legal aspects-presentation aspects

UNIT – V MATERIAL AND PROCESSES IN DESIGN 9

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

Total:45 periods

OUTCOMES: At the end of the course the students would be able to

1. Analyze the various design requirements and get acquainted with the processes involved inproduct development.
2. Apply the design processes to develop a successful product.
3. Apply scientific approaches to provide design solutions.
4. Design solution through relate the human needs and provide a solution.
5. Apply the principles of material selection, costing and manufacturing in design.

TEXT BOOKS:

1. Dieter. G. N., Linda C. Schmidt, “Engineering Design”, McGraw Hill, 2013..
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.

REFERENCES:

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, “Integrated Product and Process Design and Development”, CRC Press, 2009.

22PME72	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the fundamentals of composite material strength and its mechanical behavior
2. To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
3. To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
4. To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses inan isotropic layered structure such as electronic chips.
5. To study the fundamentals of composite material strength and its mechanical

UNIT – I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramicand Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing:Bag Moulding Compression Moulding – Pultrusion – Filament Winding
– Other Manufacturing Processes

UNIT – II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations — Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT – III LAMINA STRENGTH ANALYSIS 9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT – IV THERMAL ANALYSIS 9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations –Unidirectional, Off- axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

UNIT – V ANALYSIS OF LAMINATED FLAT PLATES 9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis.Free Vibrations — Natural Frequencies

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Summarize the various types of Fibers, Equations and manufacturing methods for
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates

TEXT BOOKS:

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw-Hill, CRCpress in progress, 1994, -.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 1998

REFERENCES:

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley andSons, New York, 1990.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford UniversityPress-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber," Reinforced Composites: Materials, Manufacturing and Design", Maneel DekkerInc, 1993.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

22PME73	ELECTRICAL DRIVES AND CONTROLCOURSE	L	T	P	C
		3	0	0	3

OBJECTIVES

1. To learn the basic concepts of different types of electrical machines and their performance.
2. To study the different methods of starting D.C motors and induction motors
3. To study the conventional and solid-state drives
4. To study the conventional and solid-state speed control of D.C. drives
5. To study the conventional and solid-state speed control of A.C. drives

UNIT – I INTRODUCTION 9

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives– heatingand cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT – II DRIVE MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors–Braking of Electrical motors — DC motors: Shunt, series, and compound - single phase and threephase induction motors.

UNIT – III STARTING METHODS 9

Types of D.C Motor starters — Typical control circuits for shunt and series motors — Three phasesquirrel cage and slip ring induction motors.

UNIT – IV CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF D.C. DRIVES 9

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard controlsystem - Using controlled rectifiers and DC choppers –applications.

UNIT – V CONVENTIONAL AND SOLID-STATE SPEED CONTROL OF A.C. DRIVES 9

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip powerrecovery scheme – Using inverters and AC voltage regulators – applications.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the basic concepts of different types of electrical machines and their performance.
2. Explain the different methods of starting D.C motors and induction motors
3. Discuss the conventional and solid-state drives
4. Describe the conventional and solid-state speed control of D.C. drives
5. Explain the conventional and solid-state speed control of A.C. drives

TEXT BOOKS:

1. Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 2006
2. VedamSubrahmaniam, "Electric Drives (Concepts and Applications)", Tata McGraw-Hill, 2010

REFERENCES:

1. Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons,2017
2. Pillai.S.K "A First Course on Electric Drives", Wiley Eastern Limited, 2012
3. Singh. M.D., K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 2006.
4. Fundamentals Of Electric Drives And Controlby B.R. Gupta and V. Singhal | 1 January2013
5. Advanced Electrical Drives - Analysis Modeling Controlby Rik De Doncker, Andre Veltman, et al. | 1 January 2014

22PME05	**POWER PLANT ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES

1. To study the coal based thermal power plants.
2. To study the diesel, gas turbine and combined cycle power plants.
3. To learn the basic of nuclear engineering and power plants.
4. To learn the power from renewable energy
5. To study energy, economic and environmental issues of power plants

UNIT – I COAL BASED THERMAL POWER PLANTS 9

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants — Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT – II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimisation. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT – III 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 – IV POWER FROM RENEWABLE 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, Geo Thermal, Biogas and Fuel Cell power systems.

UNIT – V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the layout, construction and working of the components inside a thermal power plant.
2. Explain the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.
3. Explain the layout, construction and working of the components inside nuclear power plants.
4. Explain the layout, construction and working of the components inside Renewable energypower plants
5. Explain the applications of power plants while extend their knowledge to power plant economicsand environmental hazards and estimate the costs of electrical energy production.

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", Third Edition, Tata McGraw – Hill Publishing Company Ltd.,2008.
2. A Textbook of Power Plant Engineeringby R.K. Rajput | 1 January 2016

REFERENCES:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association withthe Open University, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", SecondEdition, Standard Handbook of McGraw – Hill, 1998.
4. Power Plant Engineeringby B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar | 1 November2019
5. Power Plant Engineering, As per AICTE: Theory and Practice by Dipak Kumar Mandal, Somnath Chakrabarti, et al. | 1 January 2019

22PME07	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
2. To provide knowledge on design aspects of Refrigeration & Air conditioning systems.
3. To study the Vapour absorption and air refrigeration systems.
4. To learn the psychrometric properties and processes.
5. To study the air conditioning systems and load estimation.

UNIT – I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties — Classification - Nomenclature - ODP & GWP.

UNIT – II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle: p-h and T-s diagrams - deviations from theoretical cycle – subcooling and super heating- effects of condenser and evaporator pressure on COP- multipressure system -low temperature refrigeration - Cascade systems — problems. Equipments: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT – III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems — Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic-Vortex and Pulse tube refrigeration systems.

UNIT – IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT – V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system;Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors,Actuators & Safety controls.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the basic concepts of Refrigeration
2. Explain the Vapor compression Refrigeration systems and to solve problems
3. Discuss the various types of Refrigeration systems
4. Calculate the Psychrometric properties and its use in psychrometric processes
5. Explain the concepts of Air conditioning and to solve problems

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 3rd edition, McGraw Hill, New Delhi,2010
2. Textbook of Refrigeration And Air-Conditioning (M.E.)by R.S. Khurmi | 10 February2019

REFERENCES:

1. JonesW.P., "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann,2007
2. Roy J. Dossat, "Principles of Refrigeration", 4th edition, Pearson Education Asia, 2009.
3. Stoecker,W.F. and Jones J.W., "Refrigeration and Air Conditioning", McGraw Hill, New Delhi,1986.
4. A Textbook of Refrigeration and Air-Conditioning by R.K. Rajput | 1 January 2013

22PME74 DYNAMICS OF GROUND VEHICLES L T P C3
0 0 3

COURSE OBJECTIVES:

The objective of this course is to make the students to Develop physical and mathematicalmodels to predict the dynamic response of vehicles

UNIT I CONCEPT OF VIBRATION 9

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed

UNIT II TYRES 9

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at variousslip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride propertyof tyres. Various test carried on a tyre.

UNIT III VERTICAL DYNAMICS 9

Human response to vibration, Sources of Vibration. Suspension requirements — types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

UNIT IV LONGITUDINAL DYNAMICS AND CONTROL 9

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for differentdrive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CGlocation. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque.Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT V LATERAL DYNAMICS 9

Steady state handling characteristics. Steady state response to steering input — Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students can able to

1. Develop physical and mathematical models to predict the dynamic response of vehicles
2. Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
3. Use dynamic analyses in the design of vehicles.
4. Understand the principle behind the lateral dynamics.
5. Evaluate the longitudinal dynamics and control in an automobile

TEXT BOOKS:

1. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008
2. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive EngineersInc, 2014

REFERENCES:

1. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013
2. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005
3. John C. Dixon, "Tyres, Suspension, and Handling, " Second Edition, Society of Automotive Engineers Inc, 1996
4. Michael Blundell & Damian Harty, "The Multibody Systems Approach to VehicleDynamics",Elsevier Limited, 2004
5. R. Nakhaie Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer,2013

22PME75	TURBO MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To study the energy transfer in rotor and stator parts of the turbo machines.
2 To study the function of various elements of centrifugal fans and blowers.
3 To evaluating the working and performance of centrifugal compressor
4 To analyzing flow behavior and flow losses in axial flow compressor.
5 To study the types and working of axial and radial flow turbines.

UNIT – I WORKING PRINCIPLES 9

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.

UNIT – II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT – III CENTRIFUGAL COMPRESSOR 9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

UNIT – IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortexflow.

UNIT – V AXIAL AND RADIAL FLOW TURBINES 9

Axial flow turbines - Types — Elements - Stage velocity diagrams - h-s diagram, stage work - impulse andreaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

TOTAL : 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the energy transfer in rotor and stator parts of the turbo machines.
2. Explain the function of various elements of centrifugal fans and blowers
3. Evaluate the working and performance of centrifugal compressor.

4. Analyze flow behavior and flow losses in axial flow compressor.
5. Explain the types and working of axial and radial flow turbines

TEXT BOOKS:

1. Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., "Turbines, Compressor and Fans", 4th Edition, Tata McGraw Hill, 2011.

REFERENCES:

1. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th Edition, Butterworth-Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D," A Treatise on Turbomachines", Scitech Publications (India)Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., "Turbomachinery Performance Analysis" 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., "Gas Turbine Theory" 6th Edition, Pearson EducationLtd, 2009.
5. Venkanna, B.K., "Fundamentals of Turbomachinery", PHI Learning Pvt. Ltd., 2009.

22PME76	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.
2. To differentiate chemical and electro chemical energy-based processes.
3. To describe thermo-electric energy-based processes
4. To explain nano finishing processes.
5. To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes

UNIT – I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT – II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemicaldeburring.

UNIT – III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT – IV NANO FINISHING PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNIT – V HYBRID NON-TRADITIONAL MACHINING PROCESSES 9

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non- traditional machining processes.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Formulate different types of non-traditional machining processes and evaluate mechanical energybased non-traditional machining processes.
2. Illustrate chemical and electro chemical energy based processes.
3. Evaluate thermo-electric energy based processes.
4. Interpret nano finishing processes.
5. Analyse hybrid non-traditional machining processes and differentiate non- traditional machining processes.

TEXT BOOKS:

1. Adithan. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
2. Anand Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCES:

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987.ISBN-13: 978-0824773526.
2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000,ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt.Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN- 13: 978-3319259208.

22PBT25	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the fundamental concept and principles of industrial safety
2. To study the principles of maintenance engineering.
3. To Analyzing the wear and its reduction.
4. To study the faults in various tools, equipments and machines.
5. To study the periodic maintenance procedures in preventive maintenance.

UNIT – I INDUSTRIAL SAFETY 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT – II MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT – III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT – V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of:i. Machine tools, ii. Pumps, iii. Air compressors,
iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the fundamental concept and principles of industrial safety
2. Apply the principles of maintenance engineering.
3. Analyze the wear and its reduction.
4. Evaluate faults in various tools, equipments and machines
5. Apply periodic maintenance procedures in preventive maintenance.

TEXT BOOKS:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press,2003.

REFERENCES:

1. Edward Ghali, V. S. Sastri, M. Elboujdaini, Corrosion Prevention and Protection: Practical Solutions,John Wiley & Sons, 2007.
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.

22PME10	DESIGN OF TRANSMISSION SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
2. To understand the standard procedure available for Design of Transmission of Mechanical elements spur gears and parallel axis helical gears.
3. To learn the design bevel, worm and cross helical gears of Transmission system.
4. To learn the concepts of design multi and variable speed gear box for machine tool applications.
5. To learn the concepts of design to cams, brakes and clutches

(Use of P S G Design Data Book permitted)

UNIT – I DESIGN OF FLEXIBLE ELEMENTS 9

Design of Flat belts and pulleys - Selection of V belts and pulleys — Selection of hoisting wire ropes and pulleys — Design of Transmission chains and Sprockets.

UNIT – II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

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

UNIT – III BEVEL, WORM AND CROSS HELICAL GEARS 9

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

UNIT – IV GEAR BOXES 9

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 - Speed reducerunit. — Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT – V CAMS, CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagneticclutches. Band and Block brakes - external shoe brakes — Internal expanding shoe brake.

Total:45 periods

OUTCOMES: At the end of the course the students would be able to

1. Apply the concepts of design to belts, chains and rope drives.
2. Apply the concepts of design to spur, helical gears.
3. Apply the concepts of design to worm and bevel gears.
4. Apply the concepts of design to gear boxes.
5. Apply the concepts of design to cams, brakes and clutches

TEXT BOOKS:

1. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008.

REFERENCES:

1. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements”8th Edition, Printice Hall, 2003.
2. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
3. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
4. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley,2005
5. Sundararajamoorthy T. V, Shanmugam .N, “Machine Design”, Anuradha Publications,Chennai, 2003.

22PME77	THERMAL POWER ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

1. To study the fuel properties and arrive at proximate and ultimate analysis of fuels.
2. To study the different types of boilers and compute their performance parameters.
3. To study the performance parameters of an air compressor
4. To study the working principles of various refrigeration systems and perform cop calculations
5. To study the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads

UNIT – I FUELS AND COMBUSTION 9

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximateand Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values

UNIT – II BOILERS 9

Types and comparison, Mountings and Accessories. Performance calculations, Boiler trial.

UNIT – III AIR COMPRESSORS 9

Classification and comparison, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors

UNIT – IV REFRIGERATION SYSTEMS 9

Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations, Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration.

UNIT – V PSYCHROMETRY AND AIR-CONDITIONING 9

Psychrometric properties – Property calculations using Psychrometric chart and expressions. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling loadcalculations. Cooling towers — concept and types.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Evaluate the fuel properties and arrive at proximate and ultimate analysis of fuels.
2. Analyze different types of boilers and compute their performance parameters.
3. Evaluate the performance parameters of an air compressor
4. Apply the working principles of various refrigeration systems and perform cop calculations
5. Analyze the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads.

TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata McGraw Hill, 2010.
2. Ballaney. P, “ Thermal Engineering”, 25th Edition, Khanna Publishers, 2017

REFERENCES:

1. Ananthanarayanan P.N, “ Basic Refrigeration and Air-Conditioning”, 4th Edition, Tata McGraw Hill,2013.
2. Arora, “ Refrigeration and Air-Conditioning”, 2nd Edition, Prentice Hall of India, 2010.
3. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd,2017.
4. Nag P.K, “ Basic and Applied Thermodynamics”, 2nd Edition, Tata McGraw Hill, 2010
   Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011

22PME78	DESIGN FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To introduce economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2 To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
3 To learn design consideration principles of machining in the design of turned, drilled, milled, planed,shaped, slotted, and ground products.
4 To learn design consideration principles of welding in the design of welded products.
5 To learn design consideration principles of assembly in the design of assembled products.

UNIT – I INTRODUCTION AND CASTING 9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

UNIT – II FORMING 9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts.

UNIT – III MACHINING 9

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Groundparts.

UNIT – IV WELDING 9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

UNIT – V ASSEMBLY 9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2. Explain design consideration principles of forming in the design of extruded, stamped, and forged products.
3. Explain design consideration principles of machining in the design of turned, drilled, milled, planed,shaped, slotted, and ground products.
4. Explain design consideration principles of welding in the design of welded products.
5. Explain design consideration principles of assembly in the design of assembled products.

TEXT BOOKS:

1. James G. Bralla, “Handbook of Product Design for Manufacture”, McGraw Hill, 1986.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architecturesand Implementation, Springer, 1998.

REFERENCES:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Henry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973.
5. Matousek, "Engineering Design", Blackie & Sons, 1956.

22PME79	POWER GENERATION EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the power generation equipments types layouts working cycles.
2. To learn the fuels, combustion and burning methods of combustion system.
3. To study the various boilers and its boilers parts of steam power plant.
4. To study the basics of nuclear fuels and reactor classification.
5. To study of techno economics and operating cost and safety of power plant.

UNIT – I INTRODUCTION 9

Introduction to types, layouts and working cycles - Layouts of diesel-electric, hydro-electric, nuclear, gas turbine, steam, cogeneration, MHD and other power plants - Site selection - Reheat and regenerative steam cycles - Binary vapour cycle - Combined cycle - Topping cycle - Power plant instrumentation and control - air flow, furnace pressure, steam temperature control system - Governing system - Steam turbine.

UNIT – II COMBUSTION SYSTEM 9

Fuels, combustion and burning methods - Fuel classification - Solid, liquid and gaseous - Compositions and heating values - Classification of coal - Combustion process, atmosphere and control - ESP Furnace construction - Stokers - suspension firing - pulverised fuel firing - oil and gas burners and systems - Fuel control - Burner management system - FSSS - Ash handling system.

UNIT – III STEAM POWER PLANT 9

Steam generators - fire tube, water tube, forced circulation, once through, super charged, super critical, Lamont, Loeffler, Schmide, Hortmen and Velox boilers, Fluidised Bed & Circulated Fluidised Bed boilers - Natural, artificial, balanced and steam jet drafts - Simple problems - Functions of super heaters, economisers, air-heaters, deaerators, feed heaters, air ejectors - Feed pumps - Injectors - Feed water control- Condensers — Jet and surface type - Simple problems - Cooling towers.

UNIT – IV NUCLEAR POWER PLANT 9

Nuclear power plant - Basics of nuclear fuels - Fission and chain reaction - Reactor classification - Boiling water, pressurised water, homogeneous, gas cooled breeding and metal cooled

UNIT – V TECHNO ECONOMICS OF POWER PLANT 9

Economics and safety - Actual load curves - Fixed and operating costs - Tariff methods for electricalenergy - Peak load and variable load operations - Selection of generation type and general equipment. Introduction to safety aspects in power plants - Environmental impacts - assessment for thermal power plant.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the power generation equipments types layouts working cycles.
2. Explain the fuels, combustion and burning methods of combustion system.
3. Discuss the various boilers and its boilers parts of steam power plant.
4. Explain the basics of nuclear fuels and reactor classification.
5. Discuss of techno economics and operating cost and safety of power plant.

TEXT BOOKS:

1. Power Plant Engineering - PK Nag
2. A Textbook of Power Plant Engineering - Rajput

REFERENCES:

1. Basics of Boiler and HRSG Design - Brad Buecker
2. Steam Plant Operation-Everett B. Woodruff,Herbert B. Lammers,Thomas F. Lammers
3. Nuclear Power Plant Design and Analysis Codes Development Validation and Application2020 Edition by Jun Wang, Xin Li, Chris Allison, Judy Hohorst , Elsevier
4. A Techno-Economic Analysis of Solar Thermal Power Plant by Malik Monu and Saini R P | 8 November 2012
5. Power Plant Engineering by Dilip Vairagkar | 1 January 2019

22PME80	ADVANCED VEHICLE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the basic concepts of electric vehicle and their characteristics
2. To introduce different types of motors and the selection of motor for vehicle applications.
3. To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
4. To give an overview of networking with sensors and systems.
5. To introduce the modern methods of diagnosing on-board the vehicle troubles.

UNIT – I ELECTRIC VEHICLES 9

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT – II ELECTRIC VEHICLE MOTORS 9

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT – III AUTONOMOUS AND CONNECTED VEHICLES 9

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver AssistanceSystems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT – IV AUTOMOTIVE NETWORKING 9

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT – V ON-BOARD TESTING 9

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

TOTAL: 45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Acquire an overview of electric vehicles and their importance in automotive.
2. Discuss the characteristics and the selection of traction motor.
3. Comprehend the vehicle-to-vehicle and autonomous technology.
4. Explain the networking of various modules in automotive systems, communication protocolsand diagnostics of the sub systems.
5. Be familiar with on-board diagnostics systems.

TEXT BOOKS:

1. John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & SonsLtd., 2018
2. Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and AutonomousVehicles in Smart Cities,CRC Press, 1st Edition, 2020.

REFERENCES:

1. Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
2. Hong Cheng, ―Autonomous Intelligent Vehicles: Theory, Algorithms & Implementation‖, Springer, 2011
3. Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott | 5 September 2012
4. Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002
5. Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011

22PME81	ADVANCED INTERNAL COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the working of Gasoline fuel injection systems and SI combustion.
2. To study the working of Diesel fuel injection systems and CI combustion.
3. To Identifying the source and measure it; explain the mechanism of emission formation andcontrol methods.
4. To study the Selecting alternative fuel resources and its utilization techniques in IC engines.
5. To study the advanced combustion modes and future power train systems.

UNIT – I SPARK IGNITION ENGINES 9

Mixture requirements – Fuel injection systems – Mono-point, Multipoint & Direct injection -Stages of combustion – Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers.

UNIT – II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems – Mechanical and Common Rail Direct Injection Systems - Stages of combustion – Knocking – Factors affecting knock –Direct and Indirect injection systems –Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Combustion chambers – Turbo charging –Waste Gate, Variable Geometry turbochargers.

UNIT – III EMISSION FORMATION AND CONTROL 9

Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulatematter – Methods of controlling emissions – In-cylinder treatments – After treatment systems – Three Way Catalytic converter, Selective Catalytic Reduction, De-NOx Catalyst, Diesel Oxidation Catalyst and Particulate Traps – Methods of emission measurement – Emission norms and Driving cycles.

UNIT – IV ALTERNATIVE FUELS 9

Alcohol Fuels, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel -Properties, Suitability, Merits and Demerits – Utilisation Methods - Engine Modifications.

UNIT – V ALTERNATE COMBUSTION AND POWER TRAIN SYSTEM 9

Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI - Hybrid Electric and Electric Vehicles –- Fuel Cells.

TOTAL 45 PERIOD

OUTCOMES: At the end of the course the students would be able to

1. Explain the working of Gasoline fuel injection systems and SI combustion.
2. Explain the working of Diesel fuel injection systems and CI combustion.
3. Identify the source and measure it; explain the mechanism of emission formation and control methods.
4. Select alternative fuel resources and its utilization techniques in IC engines.
5. Explain advanced combustion modes and future power train systems.

TEXT BOOKS:

1. V. Ganesan, “Internal Combustion Engines”, V Edition, Tata McGraw Hill, 2012.
2. John B. Heywood, “Internal Combustion Engines Fundamentals”, McGraw-Hill, 1988.

REFERENCES:

1. B.P. Pundir, "IC Engines Combustion & Emission", Narosa Publishing House, 2014.
2. Duffy Smith, "Auto Fuel Systems", The Good Heart Wilcox Company, Inc., 2003.
3. EranSher, Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Academic Press, 1998.
4. K.K. Ramalingam, "Internal Combustion Engine Fundamentals", SciTech Publications, 2011.
5. R.B. Mathur and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai& Sons, 2007

22PME82	CASTING AND WELDING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the ferrous casting metallurgy and its applications.
2. To study the nonferrous casting metallurgy and its applications.
3. To study the ferrous welding metallurgy and its applications.
4. To study the welding metallurgy of alloy steels and nonferrous metals and its applications
5. To Identifying the causes and remedies of various welding defects; applying welding standards andcodes.

UNIT – I FERROUS CAST ALLOYS 9

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure-Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions-Structure and Section sensitivity Cast irons- family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels- melting procedure and composition control for carbon steels- low alloy steels - stainless steels- composition control- slag-metal reactions-desulphurization- dephosphorization, specifications for carbon steels- low alloy steels and stainless steels

UNIT – II NON-FERROUS CAST ALLOYS 9

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys — Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

UNIT – III PHYSICAL METALLURGY OF WELDING 9

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition,formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy

steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT – IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS 9

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

UNIT – V DEFECTS, WELDABILITY AND STANDARDS 9

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding standards and codes.

TEXT BOOKS:

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.
2. A.K.Chakrabarthi, ‘Casting Technology and Cast Alloys,Prentice Hall, 2005.

REFERENCES:

1. ASM International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International,2008.
2. Baldev Raj, Shankar V, Bhaduri A K, “Welding Technology for Engineers”, Narosa Publications, 2009.
3. Beeley P, “Foundry Technology" Butterworth-Heinemann, 2001.
4. R.S.Parmar, ‘Welding Engineering and Technology’, Khanna Publishers, 2010
5. John Campbell, “Casting", Butterworth-Heinemann, 2003.

22PME16	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To introduce the process planning concepts to make cost estimation for various productsafter process planning
2. To Learn the various Process Planning Activities
3. To provide the knowledge of importance of costing and estimation.
4. To provide the knowledge of estimation of production costing.
5. To learn the knowledge of various Machining time calculations

UNIT – I INTRODUCTION TO PROCESS PLANNING 9

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection

UNIT – II PROCESS PLANNING ACTIVITIES 9

Process parameters calculation for various production processes-Selection jigs and fixture selection of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies

UNIT – III INTRODUCTION TO COST ESTIMATION 9

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges- Calculation of depreciation cost

UNIT – IV PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop,Estimation of Foundry Shop

UNIT – V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time forDifferent Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling,Shaping and Planning -Machining Time Calculation for Grinding.

Total:45 periods

OUTCOMES: At the end of the course the students would be able to

1. Discus select the process, equipment and tools for various industrial products.
2. Explain the prepare process planning activity chart.
3. Explain the concept of cost estimation.
4. Compute the job order cost for different type of shop floor.
5. Calculate the machining time for various machining operations.

TEXT BOOKS:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Elsevier science technologyBooks, Dec 2002.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

REFERENCES:

1. Chitale A.V. and Gupta R.C., “Product Design and Manufacturing”, 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., “Manufacturing Processes and systems”, 9th Edition, John Wiley,1998.
3. Russell R.S and Tailor B.W, “Operations Management”, 4th Edition, PHI, 2003.
4. Mikell P. Groover, “Automation, Production, Systems and Computer Integrated Manufacturing”,Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, “Production Planning Control and Industrial Management”, KhannaPublishers 1990.

22PME83	SURFACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the fundamentals of surface features and different types of friction associated with metalsand non-metals
2. To study the different types of wear mechanism and its standard measurement.
3. To study the different types of corrosion and its preventive measures
4. To study the different types of surface properties and surface modification techniques
5. To study the various types of materials used in the friction and wear applications

UNIT – I SURFACES AND FRICTION 9

Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws offriction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT – II WEAR 9

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements

UNIT – III CORROSION 9

Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT – IV SURFACE TREATMENTS 9

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Lasersurface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT – V ENGINEERING MATERIALS 9

Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Describe the fundamentals of surface features and different types of friction associated with metalsand non-metals
2. Analyze the different types of wear mechanism and its standard measurement.
3. Analyze the different types of corrosion and its preventive measures
4. Analyze the different types of surface properties and surface modification techniques
5. Analyze the various types of materials used in the friction and wear applications.

TEXT BOOKS:

1. G.W.Stachowiak and A.W.Batchelor, “Engineering Tribology”, Butterworth-Heinemann, 2005.
2. S.K.Basu, S.N.Sengupta and B.B.Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India, 2005.

REFERENCES:

1. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.
2. Halling, J. (Editor), “Principles of Tribology “, MacMillian, 1984.

22PME84	PRECISION MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1. To study the need, significance and progress of precision manufacturing and the different levels of manufacturing.
2. To study the principle and working of different methods of precision machining.
3. To study the special construction requirements of precision machine tools.
4. To study the errors involved in precision machine tools and calculate the error budgets for a given situation.
5. To study the Selecting a suitable measurement solution to measure and characterize precision machined features.

UNIT – I PRECISION ENGINEERING 9

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy — Normal, Precision, High-precision, Ultra-precision Processes and Nanotechnology.

UNIT – II PRECISION MACHINING 9

Overview of Micro- and Nano-machining, Conventional micro machining techniques - micro-turning, micro- milling, micro-grinding, Ultra-precision diamond turning, Non-conventional micromachining techniques — abrasive jet and water jet micromachining, Ultrasonic micromachining, micro electrical discharge machining, photochemical machining, electro chemical micromachining, laser beam micromachining, Electron beam micromachining, Focused Ion Beam micromachining, etc.

UNIT – III MACHINE DESIGN FOR PRECISION MANUFACTURING 9

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings.

UNIT – IV MECHANICAL AND THERMAL ERRORS 9

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors — background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

UNIT – V MEASUREMENT AND CHARACTERISATION 9

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nano features.

Surface metrology - 3D surface topography - Need, Measurement — Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy — Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students would be able to

1. Explain the need, significance and progress of precision manufacturing and the different levels of manufacturing.
2. Explain the principle and working of different methods of precision machining.
3. Explain the special construction requirements of precision machine tools.
4. Explain the errors involved in precision machine tools and calculate the error budgets for a given situation.
5. Select a suitable measurement solution to measure and characterize precision machined features.

TEXT BOOKS:

1. Jain, V.K., Introduction to micromachining, Narosa publishers, 2018
2. Venktesh V.C., SudinIzman, Precision Engineering, Tata Mc.Graw Hill Publishing Company, New Delhi2007.

REFERENCES:

1. David Dornfeld, Dae-Eun Lee, Precision Manufacturing, Springer, 2008.
2. Jain, V.K., Micro manufacturing Processes, CRC Press, 2012.
3. Joseph McGeough, Micromachining of Engineered Materials, Marcel Dekker Inc., 2002.
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics andoptoelectronics", Taylor & Francis, 2013.
5. Murty, R.L., Precision Engineering in Manufacturing, New Age publishers, 2005.

22PME06	GAS DYNAMICS AND JET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

1 To study the fundamentals of compressible flow concepts and the use of gas tables.
2 To learn the compressible flow behaviour in constant area ducts.
3 To study the development of shock waves and its effects.
4 To study the types of jet engines and their performance parameters.
5 To learn the types of rocket engines and their performance parameters.

UNIT – I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts — nozzles and diffusers. Use of Gas tables.

UNIT – II COMPRESSIBLE FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.

UNIT – III NORMAL AND OBLIQUE SHOCKS 9

Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl — Meyer expansion and relation. Use of Gas tables.

UNIT – IV JET PROPULSION 9

Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation,cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.

UNIT – V SPACE PROPULSION 9

Types of rocket engines and propellants. Characteristic velocity — thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.

TOTAL:45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Apply the fundamentals of compressible flow concepts and the use of gas tables.
2. Analyze the compressible flow behaviour in constant area ducts.
3. Analyze the development of shock waves and its effects.

4. Explain the types of jet engines and their performance parameters.
5. Explain the types of rocket engines and their performance parameters.

TEXT BOOKS:

1. Anderson, J.D., "Modern Compressible flow", Third Edition, McGraw Hill, 2003.
2. S.M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", New Age International (P) Limited, 4th Edition, 2012.

REFERENCES:

1. R. D. Zucker and O Biblarz, "Fundamentals of Gas Dynamics", 2nd edition, Wiley, 2011.
2. Balachandran, P., "Fundamentals of Compressible Fluid Dynamics", Prentice-Hall of India, 2007.
3. Radhakrishnan, E., "Gas Dynamics", Printice Hall of India, 2006.
4. Hill and Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – Wesley, 1965.
5. Babu, V., "Fundamentals of Compressible Flow", CRC Press, 1st Edition, 2008.

22PME24	OPERATIONAL RESEARCH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To learn Selecting the constraints on the availability of resources and developing a model and rendering an optimal solution for the given circumstances.
2. To study Appraising the challenges in the transportation and production problems andfurnishing a rational solution to maximize the benefits.
3. To learn Planning the purchase/ manufacturing policies, managing the spares/ stocks andmeeting the customer demands.
4. To Analysing the queue discipline and exploring the avenues for better customer service.
5. To Investigating the nature of the project and offering methodical assistance towards decisionmaking in maintenance.

UNIT – I INTRODUCTION TO OPERATIONS RESEARCH AND LINEAR PROGRAMMING 9

Operation Research: Definition – Models – Steps – Important topics – Scope - Tools. Linear Programing(LP): Introduction – Concept (Problem mix, Assumption, Properties) –Development (Problem formulation) – Problems in: Graphical method, Simplex methods, Big M method.

UNIT – II TRANSPORTATION, ASSIGNMENT AND PRODUCTION SCHEDULING PROBLEMS 9

Transportation problems: Introduction, Model, Types — Problems in: Initial Basic (feasible) solution: Northwest Corner Cell method; Least Cost Cell method; Vogel's Approximation method and Optimal solution MODI (U-V) method. Assignment problems: Introduction,Types, Problems in Hungarian method. Production Scheduling problems: Introduction –Problems in Single Machine Scheduling: SPT; WSPT, EDDmethods — Problems inJohnson's Algorithm: n job 2 machines, n job 3 machines.

UNIT – III INVENTORY CONTROL MODELS & SYSTEMS 9

Inventory Control: Introduction, Models – Problems in Purchase and Production(Manufacturing) models with and without shortages – Theory on types of inventory control systems: P& Q, ABC, VED, FNS, XYZ, SDE and HML.

UNIT – IV QUEUING THEORY 9

Queuing Theory: Introduction; Applications; Terminology, Poisson process and exponential distribution – Problems in Single Server and Multi Server Queuing Models –Case study on simulation using Monte Carlo technique.

UNIT – V PROJECT MANAGEMENT AND REPLACEMENT MODELS 9

Project Management: Introduction; Guidelines for Networking AOA Diagrams – Problems in Critical Path Method (CPM) & Program Evaluation Review Technique (PERT) – Differences of CPM & PERT. Replacement Problems: Types – Problems in: Determination of Economic Life of an Asset – Problems in: Individual and Group Replacement Policies , Apply OR software

TOTAL :45 PERIODS

OUTCOMES: At the end of the course the students would be able to

1. Discuss the selection of the constraints on the availability of resources, develop a model andrender an optimal solution for the given circumstances.
2. Explain the appraise the challenges in the transportation and production problems andfurnish a rational solution to maximize the benefits.
3. Explain plan the purchase/ manufacturing policies, manage the spares/ stocks, and meetthe customer demands.
4. Analyze the queue discipline and explore the avenues for better customer service.
5. Investigate the nature of the project and offer methodical assistance towards decision making in maintenance.

TEXT BOOKS:

1. Pannerselvam R, “Operations Research”, 2nd Edition, PHI, 2009.
2. Hamdy A. Taha, “Operations Research an Introduction”, 10th Edition, PHI/Pearson Education, 2017.

REFERENCES:

1. Ravindran, Phillips and Solberg, “Operations Research Principles and Practice”, 2nd Edition,Wiley India, 2007.
2. Srinivasan G, “Operations Research Principles and Applications”, 3 rd Edition EEEPHI, 2017.
3. Sharma J K, “Operations Research Theory and Applications”,5th Edition, Macmillan India, 2013.
4. Premkumar Gupta and D.S.Hira, “Problems in Operations Research”, S.Chand,2009.
5. Wayne L. Winston, “Operations Research Applications and Algorithms”, 4th Edition, CengageLearning, 2004.