Study Scheme for PG in **Manufacturing Systems Engineering**
(w.e.f. 23.07.2018)

Semester I

S.No	Sub. Code	Subject Name	L	T	P	Hrs	CREDITS
1.	PCME-811	Advance Manufacturing Processes	3	0	0	3	3
2.	PCME-812	Industrial Automation	3	0	0	3	3
3.	PEME-811	Core Elective -1	3	0	0	3	3
4.	PEME-812	Core Elective-2	3	0	0	3	3
5.	RMAL-811	Research Methodology and IPR	2	0	0	2	2
6.	ACMH-811	English for Research Paper writing and Professional Communication	2	0	0	2	0
7	PCME-813	Advance Manufacturing Processes lab.	0	0	2	2	1
8.	PCME-814	Industrial Automation lab	0	0	2	2	1
9	PEME-813	Core Elective -1 lab	0	0	2	2	1
10	PEME-814	Core Elective -2 lab	0	0	2	2	1
		Total	**16**	**0**	**8**	**24**	**18**

Semester II

S.No	Sub. Code	Subject Name	L	T	P	Hrs	CREDITS
1.	PCME-821	Modeling and Simulation	3	1	0	4	4
2.	PCME-822	Computer Integrated Manufacturing	3	0	0	3	3
3.	PEME-821	Core Elective -3	3	0	0	3	3
4.	PEME-822	Core Elective -4	3	0	0	3	3
5.	ACMH-821	Constitution of India	2	0	0	2	0
6.	PCME-823	Modeling and Simulation lab	0	0	2	2	1
7	PCME-824	Computer Integrated Manufacturing Systems lab	0	0	4	4	2
8	PEME-823	Core Elective -3 lab	0	0	2	2	1
9	PCME-825	Seminar	0	0	2	2	1
		Total	**14**	**1**	**10**	**25**	**18**

Students are encouraged to go to industrial training / Internship during summer break

Semester III

S.No	Sub. Code	Subject Name	L	T	P	Hr.	CREDITS
1	PEME-911	Core Elective-5	3	0	0	3	3
2	OEXX-911	Open Elective	3	0	0	3	3
3	PCME-911	Dissertation (Part-1)	0	0	20	20	10
		Total	**6**	**0**	**20**	**26**	**16**

Semester IV

S.No	Sub. Code	Subject Name	L	T	P	Hr.	CREDITS
1.	PCME-921	Dissertation (Part-2)	0	0	32	32	16
		Total	**0**	**0**	**32**	**32**	**16**

List of Core Electives

	Core Elective-1	PEME-811(A) Industrial Engineering
		PEME-811(B) Robotics
		PEME-811(C) Machine Tool Design

Semester-I		PEME-811(D) Welding Codes and Standards
		PEME-811(E) Finite Element Method
	Core Elective-2	PEME-812(A) Design of Experiments
		PEME-812(B) Physical Metallurgy
		PEME-812(C) Maintenance Engineering
Semester-II	Core Elective-3	PEME-821 (A) Additive Manufacturing
		PEME-821 (B) Computer Aided Design (CAD)
		PEME-821 (C) Product Design and Development
	Core Elective-4	PEME-822 (A) Advanced Optimization Techniques
		PEME-822 (B) Non-conventional Machining Processes
		PEME-822 (C) Measurement and instrumentation
		PEME-822 (D) Design of Welded Structures
		PEME-822(E) Surface Engineering
Semester-III	Core Elective-5	PEME-911 (A) Quality Management
		PEME-911 (B) Supply Chain Management
		PEME-911 (C) Processing of Composites
		PEME-911 (D) Physics of Welding
		PEME-911 (E) Weldability of Engineering Materials
		PEME-911(F) Flexible Manufacturing System (FMS)

List of Core Electives lab.

Semester-I	Core Elective-1 Lab	PEME-813(A) Industrial Engineering Lab.
		PEME-813(B) Robotics Lab.
		PEME-813(C) Machine Tool Design Lab.
		PEME-813(D) Welding Codes and Standards Lab.
	Core Elective-2 Lab	PEME-814(A) Design of Experiments Lab.
		PEME-814(B) Physical Metallurgy Lab.
		PEME-814(C) Maintenance Engineering Lab.
Semester-II	Core Elective-3 Lab	PEME-823 (A) Additive Manufacturing Lab.
		PEME-823 (B) Computer Aided Design (CAD) Lab.
		PEME-823 (C) Product Design and Development Lab.

Open Elective (OEME-911)

OEME-911(A) Industrial Engineering
OEME-911(B) Robotics
OEME-911 (C) Design of Experiments
OEME-911 (D) Additive Manufacturing
OEME-911 (E) Computer Aided Design (CAD)
OEME-911 (F) Product Design and Development
OEME-911 (G) Quality Management
OEME-911 (H) Supply Chain Management
OEME-911(I) Flexible Manufacturing System (FMS)

Subject Code : PCME-811
Title of the course : ADVANCE MANUFACTURING PROCESSES

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Attain knowledge on the basic concepts on geometry of cutting tools: single point cutting tools, milling cutters and twist drill, and cutting tool materials & their properties.

CO2: Attain knowledge on the fundamentals and empirical relations used in metal cutting theory for the understanding of basic concepts, chip formation mechanism, generation of cutting forces and their impact on machining, optimization of machining operations.

CO3: Able to apply the imparted knowledge on tool wear, wear mechanism of cutting tools, tool failure, machinability and tool life principles in improving the tool life of cutting tools used in industry.

CO4: Use the principles of casting in industry/research/consultancy for producing quality castings in cost effective manner.

CO5: Use the principles of welding in industry/research/consultancy for producing welded parts considering quality and cost-effective aspects.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	1	2	1	1	1	1	2	3
CO2	2	2	2	3	1	2	1	1	2	1	2	3
CO3	2	2	3	3	3	2	2	2	1	1	2	3
CO4	2	2	3	3	3	2	2	2	1	1	2	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3
Avg.	2	2	2.6	3	2.2	2	1.6	1.6	1.2	1	2	3

Theory

Course Description	**Lecture(s)**
Unit-I	
Metal Machining	**06**
Machining, definition, and objectives. Geometry of cutting tools: single point cutting tools, milling cutters and twist drill. Sharpening and re-sharpening of cutting tools. Cutting tool materials and their properties.	
Chip Formation Mechanism	**06**
Mechanics of chip formation by single point cutting tools, drills and milling cutters. Types of chips and their characteristics, derivation to estimate shear angle, chip reduction coefficient.	
Force System in Machining	**06**
Force system during turning, frictional force system at chip tool interface, force system along the shear plane, velocity relationship to estimate chip and shear velocities. Effect of wear land on force system and Chip Formation on Residual Stresses, Forces in drilling and milling processes.	
Tool Failure and Tool Life	**06**
Tool Failure, form stability, wear of cutting tools, crater wear and flank wear, criterion of wear, tool life, machinability, Taylor's Tool Life Equation.	
Unit-II	
Casting Processes	**12**

Introduction, patterns, moulds and cores. Coating for moulds and cores, melting of metals, furnaces, cooling and solidifications of metals, mechanism of solidifications, rate of solidification, pressure die casting, centrifugal casting, continuous casting, gating system, risering of castings, defects in casting, inspection, and testing of castings. Modernization and computerization of foundries.	
Welding	**12**
Introduction, Principle of solid-state welding, Principle of fusion welding heat source, metal transfer in arc welding, heat flow characteristics, gas metal reactions, cooling of fusion weld, weld defects and inspection. Advances in welding process-Ultrasonic Welding, Electronic beam welding, Laser beam welding, Explosive Welding, and Plasma welding.	

Total = 48

Textbooks:

1. P N Rao, Manufacturing Technology, Volume 1, Tata McGraw-Hill Education
2. P N Rao, Manufacturing Technology, Volume 2, Tata McGraw-Hill Education
3. Malik & Ghosh, Manufacturing Science, EWP.
4. P L Jain, Principles of Foundry Technology, Tata McGraw-Hill Education
5. Pandey & Singh, Production Engineering Science, Standard Publishers.
6. Bhattacharya, Metal cutting Theory, Central Book Publishers.

Subject Code : PCME-812
Title of the course : INDUSTRIAL AUTOMATION

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Ability to interface computers with the outside world
CO2: Modelling of physical system dynamics
CO3: Simulation and analysis of complex physical systems
CO4: Ability to design and analyse controller for Physical systems

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	3	3	1	1	2	3	1	3
CO2	3	3	1	3	3	3	1	1	1	1	2	2
CO3	3	3	1	3	3	3	1	1	1	2	3	2
CO4	3	3	1	2	3	3	1	1	2	1	1	2
Avg.	3	3	1	2.75	3	3	1	1	1.5	1.75	1.75	2.25

Theory:

Course Description	**Lecture**
Unit-I	
Fundamentals of Electrical and Electronics	**4**
Review of semiconductor devices, operational amplifier, Configurations: Inverting,summing, integrating and differentiating. Registers, capacitors, potentiometer, R-L, RLC, The Mechatronics approach: A methodology for integrated design of Mechanical, Electronics, Electrical, Control, computer and Instrumentation, Linking between electrical and mechanical devices.	
Digital Electronics and Data Acquisition	**20**
Number systems: Binary, Octal, Hexadecimal, Conversion from Binary to Decimal, Octal and Hexadecimal and vice–versa, Binary arithmetic: Addition, subtraction, Multiplication and division.Boolean Algebra: Laws, De-Morgan's laws, Logic Gates, Truth tables, Karnaugh maps and logic circuits. Generation of Boolean function from truth tables and simplification. Multiplexer and de-multiplexer. Registers, Half adder and full adder. Adder-subtracter. Flip-flops: R-S, D and J-K. Optical encoder and strain gauge sensors. Concepts of digital and analog systems, Digital to analog conversion (DAC): R-2R and summing Op-amp circuit, Analog to digital conversion (ADC): successive approximation method. Programs for DI, DO, DA and AD for PCL 208 card.	
Unit-II	
Modelling of Physical system dynamics	06
Mathematical modeling of physical systems, system equations, Performance characteristics of First order and second order system, Basics of Bond Graphs, Elements of Bond Graphs, generation of Bond Graphs of simple systems.	
Control of physical systems	06
Basic concepts of classical control and modern control system. Stability, controllability. Deriving system equations in State Space from Bond Graphs. Control laws. Design of controller. Simulation of Physical system dynamics.	

Programmable Logic Controller	12
Function of PLC, Architecture, Components of PLC, selection of PLC, Ladder Logic diagram, Mnemonics, Logic functions: latching, sequencing, counters, shift registers, jumpers, manipulation of data, arithmetic operations	

Text Books:

1. W. Bolton, Mechatronics, Pearson Education.
2. Majumdar, Pneumatic system, TMH.
3. Andrew Parr, Hydraulic and Pneumatic systems, TMH
4. Mahalik, Mechatronics, TMH.
5. Ramachandran, Mechatronics, Wiley India

Subject Code : PEME-811 (A)
Title of the course : INDUSTRIAL ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Learn the basic concept of production and industrial engineering.
CO2: Implement various recording approaches associated with work study/ method study.
CO3: Analyse industrial systems with the quality and the value addition perspectives
CO4: Apply various techniques for optimum utilization of resources.
CO5: Apply inventory control model.

CO/PO Mapping: Strong(S) / Medium(M) / Weak(W) indicates strength of correlation:												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	1	2	2	3	3
CO2	3	3	3	3	2	3	1	3	3	2	2	3
CO3	3	3	3	3	3	3	2	2	3	3	1	3
CO4	3	3	3	3	2	2	2	3	2	1	3	3
CO5	3	3	3	3	3	3	3	1	2	2	3	3
Avg.	3	3	3	3	2.6	2.6	1.8	2	2.4	2	2.4	3

Theory

Course Description	**Lecture(s)**
Unit-I	
Introduction	8
Industrial Engineering, Definition and Evolution, Understanding Industrial System Focus: Production/Service System. Performance measures of a Production System – Production, Productivity, Efficiency, Effectiveness, Classical Industrial Engineering -Work Study: Method Study and Time Study, Human Factors, Ergonomics.	
Quality Control	**8**
Quality, TQM, SQC, Control Charts, Acceptance Quality Level (AQL), Lot Tolerance Percentage Defective (LTPD), Producer's Risk, Consumer's Risk, Operating Characteristic Curve, Simple Numerical Problems	
Value Engineering	**8**
Concept of value analysis, Aim and objectives, Phases in value analysis, Test for value analysis, Difference between V.E. and Cost Reduction Techniques, Functional Analysis System Techniques (FAST), Principles of Value Analysis.	
Unit-II	
Production and Process Planning	**8**
Objectives of PPC, Component of PPC, Phases of PPC, Process Planning, Steps in Process Planning for Flow Shop Scheduling, Types of Scheduling Systems, Master Scheduling, Order Scheduling, Comparison between Production Planning and Production Control, Sequencing. **Reliability and Maintenance**	
Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; preventive maintenance and replacement, total productive maintenance – concept and applications.	**8**
Production Planning and Inventory Control	**8**
Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production	

scheduling; MRP-II and ERP; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system; logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.	

Total=48

Text Books:

1. A. Barnes, Motion and Time Study, John Wiley & sons.
2. Dalela and Sourabh, Work Study and Ergonomics, Standard Publishers.
3. Ronald Mayer, Production Management, Tata McGraw Hill.
4. Martand Telsang, Industrial Engineering & Management, S.Chand & Company

Subject Code : PEME-811 (B)
Title of the course : ROBOTICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

CO1: Obtain knowledge and understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications
CO2: Understand the control techniques used for rehabilitation robots, namely force control
CO3: To acquire the knowledge on advanced algebraic tools for the description of motion
CO4: Design and implement control applications for autonomous mobile robots.
CO5: Understanding the dynamics of the manipulator.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	1	2	2	1	2	1	3
CO2	3	3	3	2	1	2	3	3	2	2	2	2
CO3	3	2	2	3	1	2	3	2	1	2	3	3
CO4	3	2	3	3	3	3	3	2	2	3	3	3
CO5	3	3	3	3	3	3	3	2	2	2	3	3
Avg.	3	2.6	2.8	2.4	2.2	2.2	2.8	2.2	1.6	2.2	2.4	2.8

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	04
Evolution of robot and robotics, laws of robotics, robot anatomy: Links, joints, Degrees of freedom (DOF), Arm configuration, wrist configuration, end-effector.	
Coordinate Frame, Mapping and Transforms	08
Coordinate frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices	
Kinematics	12
Denavit- Hartenberg Notation, kinematic relationship between adjacent links, Manipulator transformation matrix, Inverse kinematics. Linear and angular velocity of a rigid body, velocity propagation along links, manipulator jacobian	
Unit-II	
Dynamics	12
Two DOF manipulator- Dynamic Model, Lagrange-Euler Formulation: Velocity of a point on the manipulator, equation of motion, LE Dynamic Model algorithm, Newton-Euler Formulation: Newton equation, Euler's equation, Comparison of Lagrange-Euler and Newton-Euler Formulation	
Control of manipulators	12
Robot control problems, Robotic Control strategies like PD, PID, computed torque control, Position control, force and impedance control Applications of standard control strategies. A METLAB tutorial on using the package for Robotics	

Total=48

Text Books:

1. Mittal and Nagrath, Robotics and Control, TMH.
2. J.J. Craig, Introduction to Robotics, Pearson Education.
3. Beer and Johnston, Vector mechanics, TMH.
4. Nise, Control System Engineering,Wiley.

Subject Code :PEME-811(C)
Title of the course :MACHINE TOOL DESIGN

L	T	P	Credits	Weekly Load
3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the different types of machine tools and process parameters required for the design of machine tools.
CO2: Identify different types of tool drives and mechanisms.
CO3: Understand different machine tool elements and their requirements in machine tool design.
CO4: Study the machine tool dynamics required for the stability of the system during operation.
CO5: Know various control systems used in machine tools for satisfactory functioning

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	3	2	1	3	2	2	3
CO2	3	3	3	2	2	2	1	1	2	3	2	3
CO3	3	3	3	2	3	3	1	1	2	1	2	3
CO4	3	3	3	2	3	2	2	1	1	2	3	3
CO5	3	3	3	2	2	3	3	1	2	2	3	3
Avg.	3	3	3	2	2.2	2.6	1.8	1	2	2	2.4	3

Theory

Course Description	**Lecture(s)**
Unit-I	
Introduction	**08**
Classification of machine tools and their technological capabilities, general requirements of machine tool design. economic considerations for various machine tool.	
Machine Tool Drives and Mechanisms	**08**
Mechanical drives, rotary drives, tensioning belts, timer belts, chain-sprocket drive, gearing, gear design, hydraulic drives, conversion of rotary motion to translatory motion, generating intermittent periodic motion	
Machine Tool Elements	**08**
Spindles: Functions, requirements and materials for spindle, compliance and machining accuracy. design of spindles, Guide ways for Machine Tools: Function and types of guide ways, design and lubrication of slide ways, aerostatic slide ways, antifriction guide ways, combination guide ways Gear box: Function and design	
Unit-II	
Machine Tool Dynamics	**08**
Dynamics of cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration	
Control Systems in Machine Tools	**08**
Functions, requirements and classification of control systems, control systems for changing speeds and feeds, design of speed and feed boxes, control systems for executing forming and auxiliary motions, manual control systems, automatic control systems and adaptive control systems	
Numerical Control of Machine Tools	**08**
Fundamental concepts and classification of numerical control systems, Constructional details of CNC machining centre.	
	Total=48

Text Books:

1. N.K. Mehta, Machine Tool Design, TMH.
2. Sen and Bhattacharya, Principles of Machine Tools, CBA Publishers.
3. S.K. Basu and D.K. Pal, Design of Machine Tools, Oxford and IBH.
4. P.H.Joshi, Machine Tools Handbook, McGraw Hill.

Subject Code : PEME-811 (D)
Title of the course : WELDING CODES AND STANDARDS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to:
CO1: Understand various welding codes & standards.
CO2: Gain knowledge about industrial materials, welding consumables and their applications.
CO3: Prepare WPS and PQR for various industrial welding applications.
CO4: Understand basic testing methods for weld qualification.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	1	3	3	3	2	3	3
CO2	3	1	2	3	1	2	3	1	3	3	2	3
CO3	3	3	2	2	2	3	3	3	1	2	1	3
CO4	3	2	2	3	2	3	2	1	3	3	3	2
Avg.	3	1.75	2	2.75	1.5	2.25	2.75	2	2.5	2.5	2.25	2.75

Theory:

Course Description	**Lecture**
Unit-I	
Welding Symbols	**08**
Primary and secondary weld symbols, various information and location of this information on welding symbol.	
Structural Welding Codes	**08**
Introduction to structural welding code AWS D1.1, design requirements, allowable stress values, workmanship and inspection.	
Pressure Vessel Fabrication	**08**
Introduction to ASME section VIII- division I, design requirements, fabrication methods, joint categories, welding and inspection requirements, post weld heat treatment and hydro-testing.	
Unit-II	
Welding Procedure and Welder Qualification	**08**
Introduction to ASME section IX; introduction to Welding Procedure Specification (WPS)-essential, non-essential and supplementary essential variables, procedure qualification, Procedure Qualification Records (PQR); welders performance qualification, essential and non-essential variables, retest and re-qualification of welders. F Number, P Number and A numbers, Introduction to European standards.	
Materials and Consumables	**08**
Introduction to ASME section II part A and C; introduction to materials standards and testing of materials, consumables testing and qualification as per ASME/AWS requirements, Storage and handling of welding consumables.	
Petroleum Piping and Cross-Country Pipeline Welding	**08**
Introduction to API 5L code; Process and product standards for manufacturing of pipes -welding procedure and welder qualification, field welding and inspection requirements	

Total=48

Text Books:
1. AWS D1.1 Structural Welding Code
2. ASME Section VIII - Division 1
3. ASME Section IX

4. ASME Section II Part A and Part C

Subject Code : PEME- 812 (A)
Title of the course : DESIGN OF EXPERIMENTS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to:

CO1: Understand the basic concepts of optimization.
CO2: Understand the basic concepts of experimentation analysis like selection of random variables.
CO3: Construct mathematical model for random phenomena like Null Hypothesis and Alternative Hypothesis.
CO4: Obtain engineering solutions based on statistical analysis like Factorial Design and Taguchi Method.
CO5: Analyze the variance like one-way ANOVA, two ways ANOVA, numerical on ANOVA, Z-test and T test

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	3	2	1	2
CO2	3	3	3	3	2	1	2	1	2	2	1	2
CO3	3	3	3	3	2	2	2	1	3	2	2	2
CO4	3	3	3	3	2	3	3	1	2	2	2	3
CO5	3	3	3	3	2	2	3	1	3	3	3	3
Avg.	3	3	3	3	2	1.8	2.2	1	2.6	2.2	1.8	2.4

Theory

Course Description	**Lecture**
Unit-I	
Introduction	**08**
Brief introduction of optimization techniques, Strategy of experimentation, Basic principles of Design, Terminology used in Design of Experiment, Guidelines for designing experiments, Basic statistical concepts: Types of Data, Graphical representation of Data, Measures of Central Tendency and Dispersion, Skewness.	
Simple Comparative Experiments	**08**
Sampling and sampling Distribution, Test of significance for single mean and for difference of means of two samples, Inferences about the Differences in means: randomized designs, Inferences about the Differences in means: Paired comparison Designs, Inferences about the Variances of Normal Distributions. Test of significance based on t, F and Chi square distribution.	
Fitting Regression Models	**08**
Introduction, Linear regression models, Estimate of parameters in linear regression models, The method of least square, Hypothesis testing: Null Hypothesis, Alternative Hypothesis, Prediction of new response observations, Testing for lack of fit.	
Unit-II	
Factorial Design	**08**
Basic definition and principles, Advantages of factorials, Types of factorial design: Full factor factorial design and fraction factorial design, Design Matrix, Development of mathematical model, Regression model diagnostics.	
Taguchi method	**08**
Introduction, Concept design, Parameter design, Tolerance design, Orthogonal array experiments Taguchi quality loss function, Signal-to Noise ratio, Quality characteristics, Parameter optimization experiment, Parameter design case study.	
Analysis Of Variance (ANOVA)	**08**

Introduction, One-way ANOVA process, Two-way ANOVA process, Degrees of freedom, Case studies on Factorial design, Taguchi Method and ANOVA.	

Total=48

Text Books:

1. Douglas C Montgomery, Design and Analysis of Experiments, John Wiley
2. John P.W.M., Statistical Design and Analysis of Experiments, Macmillan,
3. Montgomery D.C., Runger G. C., Introduction to Linear Regression Analysis,
4. Taguchi, G., Introduction to Quality Engineering, Asian Productivity Organisation, UNIPUB, White Plains, New York
5. Taneja HC, Statistical Methods for Engineering and Sciences, IK International Publishing house Pvt Ltd.
6. J. Wesley Barnes, Statistical Analysis for Engineers and Scientists, McGraw Hill Inc.

Subject Code : PEME-812 (B)
Title of the course : PHYSICAL METALLURGY

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand different concepts related to crystallography of metallic materials.
CO2: Learn about the Iron Carbon equilibrium, TTT and CCT diagrams.
CO3: Learn about the principles of heat treatment and use of various heat treatment processes.
CO4: Learn about the principle of corrosion and develop knowledge about various remedial measures for its control.
CO5: Obtain a handful of knowledge about various engineering materials and their applications.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	1	1	2	3	1	3	2	2	1
CO2	3	3	2	2	2	2	3	3	3	2	1	1
CO3	1	3	3	2	3	2	2	3	2	1	3	3
CO4	3	3	2	2	2	2	1	2	3	3	2	1
CO5	1	2	2	3	3	2	2	2	3	1	3	1
Avg.	1.8	2.8	2.2	2	2.2	2	2.2	2.2	2.8	1.8	2.2	1.4

Theory

Course Description	**Lecture**
Unit-I	
Crystallography	**06**
Crystallography - space lattice - unit cell - classification of space lattices by crystal system - packing factor - indexing of crystal planes and directions in cubic and hexagonal system - defects in crystals - dislocation concepts - slip and twin crystal orientation.	
Strengthening Mechanisms	**06**
Work hardening, solid solution strengthening, strengthens by heat treatment	
Nucleation and Growth	**06**
Concept of free energy, Nucleation and crystal growth during solidification, Homogeneous nucleation, critical size of the nucleus, Ingot Structure, Coring and segregation	
Phase transformations	**06**
Basics of binary and ternary phase diagram, diffusion kinetics. Important features of pearlitic, bainitic and martensitic transformations,	
Unit-II	
Iron Iron-Carbide Equilibrium Diagram	**04**
Introduction to iron-iron carbide diagram, TTT and CCT diagrams.	
Heat treatment	**06**
Annealing, normalizing, hardening and tempering, stress relieving	
Case hardening	**04**
Carburizing, nitriding, cyaniding, flame hardening and induction hardening	
Corrosion	**04**
Introduction, various types of corrosion, and respective possible causes, Methods of preventing corrosion	

Overview of Metallic Materials	**06**
Plain carbon steels, low alloy and Q-T steels, dual phase steels, HSLA steels, Hadfield steel, stainless steels, tool steels, ultra-high strength steels- maraging steels.	

Total=48

Text Books:

1. S.H.Avner, "Introduction to Physical Metallurgy", McGraw Hill.
2. V.Raghavan, "Physical Metallurgy (Principles and Practice)", Prentice Hall.
3. D.S. Clarke and W.R.Varney, "Physical Metallurgy for Engineers", CBS.
4. T.V.Rajan, C.P.Sharma and Ashok Sharma, "Heat Treatment – Principles and Techniques", Prentice Hall of India.
5. Y.S Laktin, "Engineering Physical Metallurgy and Heat treatment", MIR publishers.
6. Metals Hand book, Volume I-VI, American Society of Metals.

Subject Code : PEME-812C
Title of the course : MAINTENANCE ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the importance of maintenance.
CO2: Understand the basics of TPM methodology.
CO3: Understand the importance of RCM and CBM.
CO4: Have an idea about performing maintenance activity of agricultural equipment.
CO5: Understand the basic techniques of restoration, repair & retrofitting.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	3	3	1	3	2	3	3
CO2	1	3	3	3	2	2	3	1	2	3	3	2
CO3	3	3	3	3	3	2	3	1	3	2	3	2
CO4	3	3	3	3	2	1	2	1	2	3	2	1
CO5	3	3	3	1	3	3	3	2	3	2	3	3
Avg.	2.6	2.6	2.8	2.2	2.2	2.2	2.8	1.2	2.6	2.4	2.8	2.2

Theory

Course Description	Lecture
Unit-I	
Maintenance Management	**08**
Introduction to Maintenance, Need of Maintenance Management, Maintenance Policies, Strategies and options in Maintenance management. Maintenance forms/actions and their inter relationships, Brief descriptions of various Maintenance actions. Maintenance Organisations: Prerequisities, factors determining effectiveness of a Maintenance organization, objectives of organization design, types of organization. Maintenance Planning and Control: Establishing a Maintenance Plan-Preliminary considerations, Systematic method of Maintenance Plan and schedule planning and schedule of Plant shut downs.	
Total productive Maintenance (TPM)	**08**
Introduction: Definition concept of TPM, characteristics of TPM, Benefits of TPM, losses of TPM, implementing TPM. Philosophy of TPM. Indications of TPM. TPM Development: Preparation phase, TPM introduction education, TPM Promotion organization, TPM policies and goods, TPM Master Plan TPM initiatives, Implementation phase; consolidation phase. Measuring TPM effectiveness: Philosophy of setting goals Measuring TPM effectiveness Indicators topes, Plant effectiveness quelling and Energy saving Maintenance Measuring TPM Benefits. Application of TPM in Process Industries Administrative & Support departments and other Industrial enterprises	
Reliability Centred Maintenance (RCM)	**08**

Introduction its place in Maintenance policies & Hierarchy aims of RCM, steps in RCM implementation, steps in RCM analysis, system selection, RCM effectiveness indicators. Maintenance informer and efficiency. RCM tasks Proactive Maintenance, Preventive and Predictive tasks. Scheduled restoration and scheduled discard. The P-F interval and P-F curves, linear as nonlinear PF curves, Default actions, RCM Decision diagrams. Implementation of RCM.	
Condition Based Maintenance	**08**
Machine signatures, various techniques of signature analysis, temperature noise, vibration and wear particle analysis, on line and off-line techniques.	
Unit-II	
Maintenance of Agricultural and Earth Moving Machinery	**06**
Maintenance scheduling, predictive and preventive maintenance, machine health monitoring systems, spare parts – inventory and maintenance. Fault diagnosis, rectification servicing and repairs of various components/systems of agricultural equipments and earth moving machinery, fault diagnosis and manuals.Special problems associated with heavy earth moving equipments and their solutions. Planning and design.	
Restoration	**06**
Restoration: Scheduled restoration and scheduled discard tasks. Restoration techniques for industrial equipments: Gear transmissions, key fittings, splines fitting, coupling & clutches, lead screw & nut, belt, chain & sprocket wheels, bush bearing ball & roller bearings their shank & housings. Restoration of parts by welding metallisation, chromium plating, maintainability for given restoration time with weibull times to restore distribution, time to restore for given maintainability with a weibull time to restore distribution, steady state mean times to actively restore, repair and /or replace components in an equipment, equipment restoration time, efficiency & consistency.	
Repairs & Retrofitting	**04**
Repair cycle, repair complexity, Assembly & disassembly of machine& components, repair of cracks, reclamation of worn & damaged parts, economics of reconditioning, reconditioning Vs replacements. Repair of Industrial equipments: Machine spindle, Hydraulic machines, tailstock, three jaw chucks, repair of cracks in C.I. Body, special features of the repair of cranes, hammers power press. Retrofitting: Retrofitting, objectives, classification of retrofitting, scope of retrofitting, Cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features &selection for retrofitting.	

Total=48

Text Books:

1. R. C. Mishra, K. Pathak, Maintenance Engineering and Management
2. K. Smit, Maintenance Engineering and Management
3. K. Venkataraman, Maintenance Engineering and Management

Subject Code : PCME-813
Title of the course : ADVANCE MANUFACTURING PROCESSES LAB.

L	T	P	Credits	Weekly Load
0	**0**	**2**	**1**	**2**

COURSE OUTCOMES:

After completion of the course students will be able to:

CO1: Attain practical knowledge on the fundamentals used in metal cutting theory for the understanding of chip formation mechanism, generation of cutting forces and their impact on machining.

CO2: Identify different cutting tool materials and cutting tools and understand their applications.

CO3: Gain practical experience to perform various sand testing processes available in the Sand Testing lab.

CO4: Gain practical experience to perform some welding processes available in the Advance Welding Lab.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	1	2	1	1	1	1	2	3
CO2	2	2	2	3	1	2	1	1	2	1	2	3
CO3	2	2	3	3	3	2	2	2	1	1	2	3
CO4	2	2	3	3	3	2	2	2	1	1	2	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3
Avg.	2	2	2.6	3	2.2	2	1.6	1.6	1.2	1	2	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study tool geometry of single point cutting tool
2.	To study tool geometry of multi point cutting tools
3.	Study of chips and determination of chip reduction co-efficient in turning mild steel by HSS tool with different depth of cut
4.	Study on the effect of tool geometry on tool wear and surface roughness in hard turning
5.	To study effect of input parameters on cutting forces and surface finish during turning
6.	To study effect of input parameters on cutting forces and surface finish during milling operation
7.	To study the performance requirements of sand testing methods of green sand
8.	To perform and study the effect of process parameters in TIG/MIG welding
9	Microstructural evaluations of TIG and MIG welded joints

Subject Code : PCME-814
Title of the course : INDUSTRIAL AUTOMATION LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Ability to interface computers with the outside world
CO2: Modelling of physical system dynamics
CO3: Simulation and analysis of complex physical systems
CO4: Ability to design and analyze controller for Physical systems

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3	3	2	2	3	1	3
CO2	3	3	3	3	3	3	2	1	1	2	3	2
CO3	3	3	3	3	3	3	2	1	3	2	3	2
CO4	3	3	3	2	3	3	2	2	2	3	3	2
Avg.	3	3	2.75	2.75	3	3	2.25	1.5	2	2.5	2.5	2.25

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study system introduction: computer-machine interface.
2.	Familiarization with Automation Studio 5.7
3.	Simulation of working of single acting and double cylinder with 3/2 DC valve.
4.	Simulation of working of double acting cylinder with 5/2 DC valve.
5.	Simulation of Pilot operation
6.	Simulation of throttle-in and throttle-out process
7.	Simulation of semi-automatic pneumatic ckt.
8.	Simulation of fully -automatic pneumatic ckt.
9.	Study and installation of DAQ board PCL- 208
10.	To study digital input (DI) and digital output (DO)
11.	To study analog to digital (A/D) conversion
12.	To study digital to analog (D/A) conversion.
13.	To study the pneumatic trainer
14.	To study the op-amp and logic gate kit
15.	Familiarization with MATLAB

Subject Code : PEME-813 (A)
Title of the course : INDUSTRIAL ENGINEERING LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Learn the basic concept of production and industrial engineering.
CO2: Implement various recording approaches associated with work study/ method study.
CO3: Analyse industrial systems with the quality and the value addition perspectives
CO4: Apply various techniques for optimum utilization of resources.
CO5: Apply inventory control model.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	1	3	2	3	3
CO2	3	3	3	3	2	3	1	1	2	3	2	3
CO3	3	3	3	3	3	2	2	2	3	3	1	3
CO4	3	3	3	3	2	3	2	1	3	3	3	3
Avg.	3	3	3	2.5	2.5	1.5	1.25	2.75	2.75	2.25	3	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Study and construct an operation process chart of a given Task
2.	Study and construct a flow process chart of a given Task
3.	Study and construct a two-handed operation chart of a given Task
4.	To obtain practice in Rating performance in walking
5.	To obtain practice in Rating performance in card Dealing
6.	To determine the Standard time, Reassemble and Assembly of different bolts by using hand Tool Dexterity Apparatus.
7.	To measure the image perception capability of an individual

Subject Code : PEME-813(B)
Title of the course : ROBOTICS LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: To develop the ability to design the motion for articulated systems.
CO2: To acquire the knowledge of programing advanced algebraic tools for the description of motion.
CO3: Obtain knowledge and understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications
CO4: Program industrial (manipulator) robots.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	1	3	1	3	3
CO2	3	3	3	1	1	3	3	2	3	2	3	2
CO3	3	1	2	3	1	2	2	3	3	2	2	3
CO4	3	3	3	2	3	3	3	1	2	3	3	3
Avg.	3	2.5	2.75	2	2	2.75	2.75	1.75	2.75	2	2.75	2.75

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Numerical analysis problems (Simpson's rule, Euler's method, Runge-kutta method etc.) using MATLAB
2.	Write a program in MATLAB for deriving D-H parameters of given Robotic Configurations
3.	Write a program in MATLAB for deriving expressions of Jacobian for given robotic manipulators
4.	Write a program in MATLAB for simulation of Dynamics of Serial Manipulators planar configurations.
5.	Write a program in MATLAB for Position control of Serial Manipulators (planar configurations).
6.	Design of Controller for position control of serial manipulators using MATLAB.
7.	Stability analysis of given dynamic system using Control system TOOLBOX of MATLAB.
8.	Virtual modeling for Kinematic and dynamic verification any one robotic structure using suitable software.
9.	Design, modeling and analysis of two different types of grippers.
10.	Study of robotic system design.

Subject Code : PEME-813 (C)
Title of the course : MACHINE TOOL DESIGN LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the different types of machine tools and process parameters required for the design of machine tools.
CO2: Identify different types of tool drives and mechanisms.
CO3: Understand different machine tool elements and their requirements in machine tool design.
CO4: Study the machine tool dynamics required for the stability of the system during operation.
CO5: Know various control systems used in machine tools for satisfactory functioning

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	3	2	1	1	1	3
CO2	3	3	3	2	2	3	3	1	1	1	1	3
CO3	3	3	3	2	2	3	3	2	1	1	1	3
CO4	3	3	3	2	2	3	3	2	1	1	1	3
CO5	3	3	3	2	2	3	3	2	1	1	1	3
Avg.	3	3	3	2	2	3	3	1.8	1	1	1	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study the classification of various types of machine tools.
2.	To study effect of speed, feed and depth of cut on machining cost on lathe machine. and obtain charts for same.
3.	To study how to design a gear box.
4.	To study the physical effect of chattering on machining a job.
5.	To draw a stability chart of chattering while doing turning on a lathe machine.
6.	To study control systems for controlling speeds and feeds in CNC.
7.	Study of international G codes and M codes of CNC.
8.	Write a program of machining on CNC in both incremental and absolute system.

Subject Code : PEME-813 (D)
Title of the course : WELDING CODES AND STANDARDS LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to:
CO1: Understand various welding codes & standards.
CO2: Gain knowledge about industrial materials, welding consumables and their applications.
CO3: Prepare WPS and PQR for various industrial welding applications.
CO4: Understand basic testing methods for weld qualification.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	3	1	2	3	3	3	3	3	3
CO2	3	2	2	3	1	2	3	2	3	2	3	3
CO3	3	3	2	3	3	3	2	3	2	2	3	3
CO4	3	3	3	3	2	2	3	1	2	3	3	3
Avg.	3	2.25	2.25	3	1.75	2.25	2.75	2.25	2.5	2.5	3	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Perform V joint welding on 12 mm thick plate of 300 x 100 mm size by SMAW process and Prepare WPS and PQR for it.
2.	Perform SAW welding on 12 mm thick plate and prepare consumable selection chart as per ASME section II
3.	Perform SAW welding on 12 mm thick plate and perform NDT test as per ASME section IX
4.	Study of Boiler safety and testing standards
5.	Study of pressure vessel fabrication and safety standards
6.	Perform low temperature impact testing on SAW welded mild steel specimen as per ASME standard testing methods
7.	Perform GMAW welding as per ASME standard and prepare WPS/PQR
8.	Perform tensile testing on GMAW welded mild steel specimen as per standard testing method.

Subject Code : PEME- 814 (A)
Title of the course : DESIGN OF EXPERIMENTS LAB

L	T	P	Credits	Weekly Load
0	**0**	**2**	**1**	**2**

COURSE OUTCOMES:
After successful completion of course, the students should be able to:
CO1: Understand the basic concepts of optimization.
CO2: Understand the basic concepts of experimentation analysis like selection of random variables.
CO3: Construct mathematical model for random phenomena like Null Hypothesis and Alternative Hypothesis.
CO4: Obtain engineering solutions based on statistical analysis like Factorial Design and Taguchi Method.
CO5: Analyze the variance like one-way ANOVA, two ways ANOVA, numerical on ANOVA, Z-test and T test

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	3	3	2	2	1	2
CO2	3	3	3	3	2	2	2	2	2	2	1	2
CO3	3	3	3	3	2	2	3	3	3	2	2	2
CO4	3	3	3	3	2	2	3	2	2	2	2	2
CO5	3	3	3	3	2	2	3	3	3	2	2	3
Avg.	3	3	3	3	2	2	2.8	2.6	2.4	2	1.6	2.2

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study the Strategy of experimentation
2.	Test of significance based on t test.
3.	Test of Means - One Factor Experiment based on F test through ANOVA.
4.	Test of significance based on Chi square distribution.
5.	Development of mathematical model through Full factor factorial design (A case study)
6.	Development of mathematical model through fraction factorial design (A case study)
7.	Case studies on Orthogonal array experiments with L-9 Taguchi Method
8.	Case studies on Orthogonal array experiments with L-27 Taguchi Method
9.	Case study on one-way ANOVA process
10.	Case study on two-way ANOVA process

Subject Code : PEME 814 B
Title of the course : PHYSICAL METALLURGY LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the various metallic structures and plastic deformation.
CO2: learn the principles of heat treatment and various heat treatment processes.
CO3: Know about the basic mechanisms of Phase transformations observed during the heat treatments.
CO4: Know various engineering materials, their mechanical properties and applications.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	1	1	2	3	1	3	2	2	1
CO2	3	3	2	2	2	2	3	3	3	2	1	1
CO3	1	3	3	2	3	2	2	3	2	1	3	3
CO4	3	3	2	2	2	2	1	2	3	3	2	1
Avg.	2	3	2.25	1.75	2	2	2.25	2.25	2.75	2	2	1.5

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
11.	Cursory examination of different ferrous and non-ferrous materials.
12.	Demonstration of Furnaces used in Heat treatment.
13.	Study of Crystal systems and model making for various metallic structures e.g. BCC, FCC and HCP structures.
14.	Study of Iron Carbon equilibrium diagram and identification of various phases on it.
15.	Study of Principles of Heat Treatment and, TTT curves.
16.	To perform Hardness Testing on a given specimen.
17.	To Perform Tensile testing on UTM.
18.	To Perform Impact Testing of the given samples.
19.	To Perform Quenching of low alloy steel specimens in various media.
20.	Study various Surface hardening treatments and perform carburizing treatment.
21.	To prepare a given specimen for metallographic examination.
22.	To observe the microstructure of the specimens prepared for metallographic examination.

Subject Code : PEME-814C
Title of the course : MAINTENANCE ENGINEERING LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the importance of maintenance.
CO2: Understand the basics of TPM methodology.
CO3: Understand the importance of RCM and CBM.
CO4: Have an idea about performing maintenance activity of agricultural equipment.
CO5: Understand the basic techniques of restoration, repair & retrofitting.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	3	3	1	3	2	3	3
CO2	1	3	3	3	2	2	3	1	2	3	3	2
CO3	3	3	3	3	3	2	3	1	3	2	3	2
CO4	3	3	3	3	2	1	2	1	2	3	2	1
CO5	3	3	3	1	3	3	3	2	3	2	3	3
Avg.	2.6	2.6	2.8	2.2	2.2	2.2	2.8	1.2	2.6	2.4	2.8	2.2

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study the Prerequisities, factors and objectives of organization design.
2.	To study TPM preparation, implementation & consolidation phase.
3.	To study P-F interval and P-F curves.
4.	To study the implementation of RCM and their decision diagrams.
5.	To study the different techniques of signature analysis.
6.	To study special problems associated with heavy earth moving equipment and their heavy earth moving equipment and their solutions.
7.	To study different equipment's like splines fitting, lead screw, nut, belt, chain & sprocket wheels and different methods of restoration of parts.
8.	To study objectives, classification, scope of retrofitting.

Subject Code : PCME-821
Title of the course : MODELLING AND SIMULATION

L	T	P	Credits	Weekly Load
3	1	0	4	4

COURSE OUTCOMES:
After successful completion of course, the students should be able to:

CO1: Identify the underlying concepts; advantages, limitations and usefulness of modeling & simulation of engineering systems in general, and that of manufacturing systems in particular**.**
CO2: Construct mathematical model for continuous and discrete engineering systems.
CO3: Obtain random samples by generating & testing random numbers [0, 1], and converting to random variates as per appropriate statistical (probability) distribution.
CO4: Simulate the problems of manufacturing systems and management science using appropriate set of random samples.
CO5: Design the simulation experiment for static, dynamic and stochastic systems.

CO/PO Mapping: Strong(3) / Medium(2) / Weak(1) indicates strength of correlation:															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**05**
Concept of system & environment, elements of systems, types of systems, system modelling, types of models. System simulation, simulation as a management laboratory, advantages & limitations of system simulation.	
Simulation of Continuous system	**07**
Examples of continuous system simulation – pure pursuit problem and chemical reactor problem, simulation using MATLAB programming, characteristics of continuous systems, comparison of numerical integration with continuous system simulation, selection of integration formula for simulation.	
Simulation of Discrete System	**07**

Time flow mechanisms, generation of random numbers, testing of random numbers for uniformity & statistical independence. Discrete and continuous probability density functions (binomial, uniform, exponential, normal and beta density functions). Generation of random variates for discrete probability distribution, generation of random variates for continuous probability distribution. Combination of discrete-event and continuous models, simulation using MATLAB programming.	
Simulation of queuing system	**07**
Concept of queuing theory, characteristics of queues, measure of system performance, Kendell's notation. Simulation of single-server and double-server queues. Queues involving complex arrivals and service times with balking, reneging and jockeying, stationary and time dependent queue, auto covariance and auto correlation function, auto correlation effects in queuing system, simulation using MATLAB programming.	
Unit-II	
Simulation of inventory system	06
Rudiments of inventory theory – analytical approach. Necessity of simulation, simulation of inventory systems. Demand forecasting and regression analysis; time series analysis, exponential smoothing and simulation-based forecasting approaches, simulation using MATLAB programming	
Simulation of project management problems	06
Introduction to PERT & CPM for project management, time estimates, identification of critical path for estimation of project completion time, necessity of simulation, simulation of project management problem(s), simulation using MATLAB programming.	
Design of simulation experiments	06
Length of simulation run, run length for static stochastic simulation, run length for dynamic stochastic simulation - elimination of transients (initial bias), auto-correlated observations, blocking, etc. Variance reduction techniques - antithetic sampling, correlated sampling, importance sampling, control variates, stratified sampling, etc.	
Simulation Languages	06
Continuous and discrete simulation languages block structure continuous languages, special purpose simulation languages.	

Total=50

Text Books:

1. Loffick, Simulation and Modeling, Tata McGraw Hill.
2. Deo Narsingh, System Simulation with Digital Computer, Prentice Hall of India.
3. D.S. Hira, System Simulation, S. Chand & Co.
4. Gorden, System Simulation, Prentice Hall.
5. David Kelton, Simulation Modeling & Analysis, Tata McGraw Hill.

Subject Code : PCME-822
Title of the course : COMPUTER INTEGRATED MANUFACTURING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Enhance the knowledge of application of computers in manufacturing processes.
CO2: Improvement in the management skills.
CO3: To motivated in field of automation.
CO4: Develop the knowledge of modern quality checkup.
CO5: Modernization ways enhancement.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	2	3	3	3	1	3	3	3	3
CO2	2	3	3	3	1	3	3	2	3	3	3	2
CO3	2	3	2	2	3	1	3	1	3	2	2	3
CO4	2	3	3	3	3	3	3	1	2	3	2	2
CO5	3	3	2	1	3	2	3	1	3	3	2	3
Avg.	2.2	3	2.2	2.2	2.6	2.4	3	1.2	2.8	2.8	2.4	2.6

Theory

Course Description	Lecture
Unit-I	
Computer Aided Manufacturing (review)	**04**
Introduction to conventional and modern manufacturing systems. NC, CNC, DNC and adaptive control	
Material handling	**06**
Principles and characteristics of material handling systems. Conveyor Systems, Automated storage and retrieval system (AS/RS), AGV.	
Robotics	**08**
Introduction, Basic motions, Precision of movements, Introduction to robot programming, End of arm tooling, Sensors, robot terminology, case study like pick and place of bolt for processing.	
Automated Inspection Quality Control	**06**
Automated inspection, introduction to Coordinate measuring machines (CMM), Surface measurements, machine vision, other optical inspection techniques, non-contact non optical inspection techniques	
Unit-II	
Flexible Manufacturing Systems	**08**
Cellular manufacturing, components of FMS, types, design, implementation issues.	
Information management	**08**
Group technology, CAPP, Material requirement planning (MRP), Capacity Planning, Shop floor control, Inventory control.	
Project management	**08**
Introduction, time management, team management, cost management, risk management, introduction to lean manufacturing, cost analysis.	
	Total=48

Text Books:

1. Groover, M. P, Automation, Production Systems and Computer Integrated Manufacturing, PHI.
2. Shivanand, Benal, Koti , Flexible Manufacturing System, New Age
3. Groover &Zimmers, CAD/CAM Computer-Aided Design and Manufacuring, Pearson
4. Chang, Wysk, Wang , Computer-aided Manufacturing, PHI.
5. Heerkensens, Project Management ,McGraw Hill

Subject Code : PEME-821(A)
Title of the course : ADDITIVE MANUFACTURING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To apply knowledge leaned on AM and RE technologies for product development.

CO2: Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available. •

CO3: To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies

CO4: To analyse principles behind AM and RE techniques, and to be fluent in selecting additive manufacturing processes, devices and materials to suit product requirements.

CO5: To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	3	1	3	3	1	3	3
CO2	3	3	3	1	3	3	1	1	2	1	3	3
CO3	3	3	3	2	3	1	3	3	3	3	2	3
CO4	3	3	2	3	2	2	1	3	3	3	1	3
CO5	3	2	1	3	3	2	3	1	3	3	3	3
Avg.	3	2.6	2.2	2.4	2.8	2.2	1.8	2.2	2.8	2.2	2.4	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**10**
Additive Manufacturing: Overview, History, Need and Classification, Prototype Fundamentals, Additive Manufacturing Concepts in product development, Materials for Additive Manufacturing Technology, Data Interfacing for Additive Manufacturing.	
Liquid Based and Solid Based Additive Manufacturing Systems	**10**
Classification, Liquid based system, Stereolithography Apparatus (SLA): Principle, process, advantages and applications, Solid based system, Fused Deposition Modeling: Principle, process, advantages and applications, Laminated Object Manufacturing.	
Powder Based Additive Manufacturing Systems	**10**
Selective Laser Sintering: Principles, Process, advantages and applications, Three-Dimensional Printing: Principle, process, advantages and applications. Laser Engineered Net Shaping (LENS), Electron Beam Melting. Evaluation and Comparison of AM Technologies; AM Technologies in Research	
Unit 2	
Reverse Engineering	**12**
Introduction to Reverse Engineering, Data Capturing Technologies, Model Reconstruction, Data Processing for Additive Manufacturing Technology: CAD model preparation, Part Orientation and support generation, Model Slicing, Tool path Generation., RE-AM integration. Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.	
Additive Manufacturing and Reverse Engineering in Industrial Applications	**06**
Applications of Additive Manufacturing in Manufacturing and Tooling, Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Biomedical Applications of AM: Medical, Biomedical,	

Dental, Bio-printing, Tissue & Organ Engineering and many others- Computer Aided Tissue Engineering (CATE): Case studies.	

Total=48

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S, Rapid Prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2010.
2. C. K. Chua, and K. F. Leong, 3D Printing and Additive Manufacturing: Principles and Applications, 3rd Edition, World Scientific Publishing Company, 2014
3. K.G. Cooper, Rapid Prototyping Technology: Selection and Application, Marcel Dekker, 2001
4. Gebhardt A, Rapid prototyping, Hanser Gardener Publications, 2003.
5. Liou L.W. and Liou F.W, Rapid Prototyping and Engineering applications : A tool box for prototype development, CRC Press, 2007.
6. Kamrani A.K. and Nasr E.A, Rapid Prototyping: Theory and practice, Springer, 2006.
7. Hilton P.D. and Jacobs P.F, Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.
8. W.M. Steen, Laser Material Processing, 2nd Edition, Springer, 1998.

Journals and Magazines:

- Rapid Prototyping Journal, Emerald
- Computer Aided Design, Elsevier
- International Journal of Advanced Manufacturing Technology, Springer
- International Journal of Computer Integrated Manufacturing, Taylor and Francis
- Virtual and Physical Prototyping, Taylor and Francis.

Subject Code : PEME-821 (B)
Title of the course : COMPUTER AIDED DESIGN (CAD)

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Create the different wireframe primitives using parametric representations.
CO2: Create surface primitives using parametric modeling.
CO3: Create the different solid primitives using the different representation schemes.
CO4: Apply geometric transformations on the created wireframe, surface and solid models.
CO5: Impart advanced education in the fields of design

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	1	2	1	2	3
CO2	3	3	3	2	3	2	1	1	2	1	1	3
CO3	3	2	1	2	2	2	2	1	2	1	1	3
CO4	3	3	1	2	2	2	2	1	2	1	2	3
CO5	2	1	1	2	2	3	2	3	2	1	2	3
Avg.	2.8	2.4	1.8	2	2	2.2	1.8	1.4	2	1	1.6	3

Theory:

Course Description	**Lectures**
UNIT I	
Introduction	**06**
Definitions, Historical Development. Geometric Modeling, Nameable and Unnamable shapes, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.	
Design of Curves	**10**
Algebraic and Geometric Forms, Parametric space of a curve, Blending functions, Reparametrization, Truncating, Extending and subdividing, Space curve, Four point form, Straight lines, Spline Curves, Bezier Curves, B-spline Curves, Rational Polynomials, introduction to NURBS	
Design of Surfaces	**08**
Algebraic and Geometric form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Reparametrization of a surface patch, subdividing, Sixteen Point form, Four Curve Form, Plane surface, Cylindrical Surface, Ruled surface, Surface of Revolution. Bezier Surface, B-Spline Surface.	
UNIT II	
Solid Modeling Fundamentals	**08**
Topology of Closed Paths, Piecewise flat surfaces, topology of closed curved surfaces, Generalized Concept of boundary, Set theory, Boolean operators, Set-membership Classification, Euler operators, Formal Modeling Criteria, Constructive Solid Geometry, Boundary Representation.	
Transformations	**06**
Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation	
Introduction to Assembly-modeling	**05**

Introduction to assembly, Analytical Properties, Relational Properties and intersections, Data transfer formats.	
Applications	**05**
Implementation of the algorithms on MATLAB, Construction of Solid and Surface Models on any of the high end solid modelers (IDEAS / ProE and Imageware Surfacer).	

Total=48

Text Books:

1. Michael E. Mortension ,Geometric Modeling, John Wiley.
2. Zeid, I., CAD/CAM, McGraw Hill (2008).
3. Rogers, D. F. and Adams, J. A., Mathematical Elements for Computer Graphics, McGraw Hill (1989).
4. Rogers, D. F., Procedural Elements for Computer Graphics, McGraw Hill (2008).
5. Rooney, J. and Steadman, P., Principles of Computer Aided Design, prentice Hall (1988).
6. Rooney, J. and Steadman, P., Computer Aided Design, Pitman/Open University (1987).
7. Mallineuse, G., Computational Concepts and Methods, Kogan Page Ltd. (1986)

Subject Code : PEME-821 (C)
Title of the course : PRODUCT DESIGN AND DEVELOPMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the prerequisites of the product design & development, concept of product life cycle, including PLM framework, product data management, system integration and quality issues.
CO2: Apply the concept of value engineering and value analysis to product design & development.
CO3: Understand the underlying issues on material and process selection for product design & development.
CO4: Apply the concept of design for manufacture and assembly, incorporating other life cycle issues at the design stage.
CO5: Understand the principles of engineering ethics and liability issues; and apply the basic tools of design protection.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	2	3	3	3	2	3
CO2	3	3	3	2	2	2	2	2	2	2	2	3
CO3	3	2	2	2	1	2	2	2	2	2	1	3
CO4	3	3	2	2	3	2	1	3	2	2	1	3
CO5	1	2	1	2	2	3	2	3	2	2	1	3
Avg.	2.6	2.6	2.2	2	2	2.4	1.8	2.6	2.2	2.2	1.4	3

Theory:

Course Description	Lecture
UNIT I	
Stages in Design process	**07**
Introduction to various stages of the design process: Identify Customer Needs, establish target specifications, Generate and Test Product concept, Final Specifications, Product architecture, Industrial Design, Case study.	
Product life cycle	**08**
New product introduction: early introduction, increased product life. Product Lifecycle Management: Product information, PLM framework, Enabling technologies, Product data management (PDM), Functions of PDM software. System integration, QFD, House of quality, Case studies.	
Value engineering	**05**
Introduction, nature and measurement of value, Value analysis job plan, Creativity and techniques of creativity, Value analysis test, Case studies	
Concurrent/ reverse engineering	**04**
Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering.	
UNIT II	
Design for Manufacture	**06**
Product design for life-cycle, concurrent engineering, Design for Excellence (DFX), design for manufacture, rule-based and plan based DFM, automated manufacturability assessment, Automated manufacturability assessment.	
Product Assembly & Testing	**06**

Product design for a given need or identified need, Development and evaluation of multiple solutions and concepts, Manufacturability assessments of given design, Product Costing and Bill of Materials, Process planning for components and assembly, Product manufacturing and Testing. Establishing techno-economic feasibility product testing and *Management Studies* test marketing.	
Product Management	**07**
Commonly used DFX tools including, QFD, POKA YOKE, FMEA, Design for manual assembly and automated assembly, design for environment, Industrial and real-life case studies of DFX. product manager-functions and tasks-tools and techniques. Brand extensions, acquisitions, Brand value, Consumer insight. Strategies brand management.	
Patents, liability and ethics	**05**
Introduction, Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations, Examples/ case studies	

Total=48

Text Books:

1. Karl T. Ulrich, Steven D. Eppinger, Product Design & Development, Mc GrawHill.
2. John M. Usher, Utpal Roy and H. R. Parasaei, Integrated Product and Process Development, Tata McGraw Hill.
3. G. Boothroyd, P. Dewhurst and W. Knight, Product Design for Manufacture and Assembly, Marcel Dekker.
4. A. K. Chitale and R. C. Gupta, Product Design and Manufacture, PHI.
5. Mahmoud M. Farag, Selection of Materials and Manufacturing Processes for Engineering Design, Printice Hall.
6. M. F. Ashby, Material Selection in Mechanical Design, Elsevier.
7. Biren Prasad, Concurrent Engineering, Prentice Hall.

Subject Code : PEME 822 (A)
Title of the course : ADVANCED OPTIMIZATION TECHNIQUES

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand and formulate solution intricacies of linear programming problem, and obtain the sensitivity of optimal solution using graphical approach.
CO2: Learn the underlying concepts of nonlinear programming problem, including solution of nonlinear programming problem without constraints, and those with ≤, = and ≥ type constraints.
CO3: Formulate the integer programming problems for engineering applications, and to acquire the familiarity with the conventional methods of solution.
CO4: Understand the difference between traditional and nontraditional optimization techniques, with regard to advantages, limitation and applications.
CO5: Apply the simple genetic algorithm to an optimization problem.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	2	1	2	1	1	3
CO2	3	3	3	3	2	1	2	1	2	1	3	3
CO3	3	3	3	3	2	2	2	1	2	1	2	3
CO4	3	3	3	3	2	2	1	1	2	1	2	2
CO5	3	3	3	3	3	2	2	1	2	1	1	3
Avg.	3	3	3	3	2.2	1.6	1.8	1	2	1	1.8	2.8

Theory

Course Description	**Lecture**
Unit-I	
Linear programming	**12**
Modelling of linear programming problem – a few examples; Solution of linear programming problem – simplex method, two-phase method, M-method; Sensitivity analysis – graphical approach	
Non-linear programming	
Convex and non-convex search space, Kuhn-Tucker conditions, Hessian matrix; Transformation of constrained optimization problems into unconstrained ones – penalty function approach; Direct search – variable elimination method, random search method	**12**
Unit-II	
Integer Programming	**12**
Modelling of integer programming problem – a few examples; Solution of integer programming problem – branch & bound algorithm, cutting-plane algorithm; Traveling salesman problem – formulation, solution and practical applications	
Heuristic models	
Limitations of traditional optimization approaches to solve real world problems, Population based optimization techniques, Simple genetic algorithms – introduction, representation of variables, fitness function, genetic operators – reproduction, crossover, mutation; Advantages and limitations of population-based optimization techniques over the point-to-point based ones, Multi objective optimization, case study.	**12**

Total=48

Text Books:

1. Taha, H. A , Operations Research , PHI.
2. Deb, K, Optimization of Engineering Design, PHI.
3. D.S. Hira, P. K. Gupta , Operations Research, S. Chand.
4. Rao, Optimization techniques, New Age International.

Subject Code : PEME-822 (B)
Title of the course : NON-CONVENTIONAL MACHINING PROCESSES

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Understand the various non-conventional machining processes and their classifications.
CO2: Identify different process parameters required for selection of the processes.
CO3: Understand different mechanical energy-based processes.
CO4: Understand electro-chemical processes and their variants.
CO5: Know various thermal metal removal processes and their classification

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	2	1	1	2	2	3
CO2	3	3	3	2	2	2	3	1	2	1	1	3
CO3	3	3	3	2	3	2	2	1	2	2	2	3
CO4	3	3	2	2	3	3	2	1	1	1	1	3
CO5	3	3	2	2	3	3	2	1	2	1	2	3
Avg.	3	3	2.6	2	2.6	2.4	2.2	1	1.6	1.4	1.6	3

Theory

Course Description	**Lecture(s)**
Unit-I	
Overview of mechanical removal processes	**12**
Introduction, Classification of various non-conventional machining processes. Working principle, selection of processes, mechanism of material removal, Horn design, process capabilities, applications & limitations of the Ultrasonic Machining (USM)	
Abrasives water-jet processes	**12**
Working principles, mechanism of material removal study and selection of process parameters, machining characteristics, applications & limitations of the following processes, Abrasive Jet Machining (AJM), Water Jet machining (WJM), Abrasive Water Jet Machining (AWJM), Abrasive Flow Machining Process (AFM).	
Unit-II	
Electro chemical processes	**12**
Principle of operation, mechanism of material removal, study of equipment and selection of process parameters, process capabilities, tool design applications & limitations of the following processes, Chemical Machining (CM), Electro chemical machining (ECM). Electrochemical Honing, Electrochemical de-burring, Electro stream and shaped Tube Electrolytic Machining.	
Thermal metal removal processes	**12**
Thermal energy methods of material processing by Electric Discharge Machining (EDM), Electron Beam Machining (EBM), Ion-Beam Machining (IBM), and Laser Beam Machining (LBM), Introduction to new concept of High-Speed Machining, Ultra-Precision Machining and Hard Turning	
	Total=48

Text Books:

1. P.K. Mishra, Non-Conventional Machining, Narosa Publishing House.
2. Pandey & Shan, Modern Machining Methods, TMH.
3. Mc Geough, Principles of Electrochemical Machining, Chapman & Hall.
4. Arata. A, Plasma, Electron and Laser beam Technology, ASM.

5. Bijoy Bhattacharyya & Biswanath Doloi, Modern Machining Technology: Advanced, Hybrid, Micro Machining and Super Finishing Technology, Elsevier.

Subject Code : PEME-822 (C)
Title of the course : MEASUREMENT AND INSTRUMENTATION

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Understand significance and basic principles of measuring instruments.
CO2: Know the measuring problems and errors encountered in the measurement system.
CO3: Acquire the data and selection of specific processing methodologies to analyse the data.
CO4: Understand the construction and working of various industrial devices used to measure temperature, level, vibration, flow and viscosity.
CO5: Analyse, formulate and selection of suitable sensor for the given industrial applications.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	3	2	3	2	2	2	3
CO2	3	2	3	3	1	1	2	3	3	2	3	1
CO3	3	3	1	2	3	2	1	3	3	2	1	2
CO4	3	2	3	3	1	2	2	2	3	2	3	2
CO5	3	3	3	1	2	3	3	3	3	2	3	2
Avg.	3	2.4	2.4	2	1.6	2.2	2	2.8	2.8	2	2.4	2

Theory:

Course Description	**Lecture**
Unit-I	
Significance of Measurement and Instrumentation	**04**
Introduction; generalized configuration and functional stages of measuring systems. information, energy and incremental models; characteristics of instruments, design and selection of components of a measuring system.	
Errors in Measurement and Its Analysis	**04**
Causes and types of experimental errors; systematic and random errors. Uncertainty analysis; computation of overall uncertainty; estimation for design and selection for alternative test methods, Calibration of measuring instruments.	
Transducers	**08**
Developments in sensors, detectors and transducer technology; displacement transducers; force, torque and motion sensors; piezoelectric transducers; capacity type transducers; Strain gage transducers; accelerometers, pressure transducers based on elastic effect of volume and connecting tubing.	
Static & Dynamic Response of Instruments	**08**
Mathematical model of a measuring system, response of general form of instruments to various test inputs; dynamic response for first and second order instruments. Elementary transfer functions and Bode plots of general transfer functions.	
Unit-II	
Data Acquisition and Signal Processing	**10**
Systems for data acquisition and processing; modules and computerized data system; digitization rate; time and frequency domain representation of signals, and Nyquist criterion. Statistical parameter in signal analysis, different signal processing tools.	
Flow Measurement	**04**
Flow visualization, shadowgraph; schlieren and interferometric techniques; Pitot static tubes; hot wire anemometers; Laser Doppler velometer; flow measurements using Coriolis effect.	

Temperature and Heat Flux Measurement	**04**
Thermoelectric sensors; electric resistance sensors; thermistors; radiations pyrometers; Temperature measuring problems in flowing fluids, dynamic compensation.	
Pressure, Force and Torque Measurement	**06**
Mechanical and electromechanical methods for pressure, force and torque measurement. Orientation of sensors and design of electric /electronic circuits of the same.	

Total=48

Text Books:

1. Doeblin E. O., "Measurements System Application and Design", 5th Ed., McGraw Hill
2. Trietly Harry L., Dekker Marcel, "Transducers in Mechanical and Electronic Design", 1st Ed., CRC Press.
3. Beckwith T. G., Marangoni R. D., and Lienhard J. H., "Mechanical Measurements", 6th Ed., Prentice Hall.
4. Eckert E. R. G. and Goldstein R. J., "Measurements in Heat Transfer", 2nd Ed., Springer.
5. Goldstein R. J., "Fluid Mechanics Measurement", 1st Ed., Hemisphere Publishing Company.

Subject Code : PEME-822 (D)
Title of the course : DESIGN OF WELDED STRUCTURES

L	T	P	Credits	Weekly Load
3	**0**	**0**	**3**	**3**

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the importance of material properties and learn about weld joints, weld symbols and principles of joint design used in welding.

CO2: Analyze the welded joints subjected to different types of loading conditions (static as well as dynamic like fatigue) and make calculations regarding weld size accordingly.

CO3: Learn, understand, identify and predict about different types of fracture in welds.

CO4: Understand the concept of fracture toughness in welding.

CO5: Learn, calculate and gain knowledge about estimation and costing involved in welded fabrications.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	2	2	1	2	3	3	3
CO2	3	3	3	3	3	3	2	1	3	3	2	2
CO3	3	2	2	3	2	2	2	3	2	3	3	2
CO4	2	1	3	3	1	2	2	1	2	2	3	2
CO5	3	1	2	3	2	1	2	1	3	3	2	3
Avg.	2.8	1.8	2.4	2.6	2	2	2	1.4	2.4	2.8	2.6	2.4

Theory:

Course Description	**Lecture**
Unit-I	
Properties of Materials	**06**
Importance of properties, tensile, compressive, shear, fatigue, impact	
Weld Joints, Weld Symbols and Principles Of Joint Design	**06**
Welded joints and their types, types of welds, weld symbols, general and specific joint design principles	
Fundamentals of Design and Weld Design for Static Loading	**06**
Introduction to analysis by bending, shear deflection in beams, deflection of curved beams, designing for torsional loading, calculations for weld size. Cases of different types of welded joints: Parallel fillet, transverse fillet, circular fillet weld subjected to torsion and bending moment, Butt joints	
Weld Design for Dynamic Loading	**06**
Fatigue loading of welds: Characteristics of fatigue failure, fracture mechanism, types of fatigue failure, factors affecting fatigue life, techniques/methods for improving fatigue life of welded structures	
Unit-II	
Fracture Toughness in Welding	**12**
Introduction to fracture toughness, Types of fracture: ductile and brittle, factors affecting types of fracture, Plane stress and plane strain conditions in welds, Modes of crack extension in materials. Classification of engineering materials on the basis of fracture toughness Methods for determining fracture toughness of welds: (i) Concept of LEFM (Linear elastic fracture mechanics) Concept of (EPFM) (Elastic plastic fracture mechanics	
Costing for Welding	**12**

Definition of terms, composition of welding costs- equipment cost, cost of consumables, labour cost, overhead cost, total cost- method of calculating these costs. Standard time and method of calculating standard time	

Total=48

Text Books:

1. Omer W. B., „Design of Weldment, James.F. Lincoln Arc Welding Foundation, 1991.
2. Gray T. G. E. „Rational Welding Design, Butterworths.
3. Hertzberg R.W., „Deformation and Fracture of Mechanics of Engineering Materials, John Wiley.
4. Dieter G.,„Mechanical Metallurgy, Tata McGraw Hill.
5. Guerey T.R., „Fatigue of Welded Structure, Cambridge University Press.
6. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers.
7. R. S. Parmar, Welding Engineering & Technology, Khanna Publishers

Subject Code : PEME-822 (E)
Title of the course : SURFACE ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn about surface engineering, its importance and practical applications.

CO2: Demonstrate comprehensive knowledge of the various surfacing materials and processes/techniques involved in surface engineering.

CO3: To know the principal methods, areas of application, possibilities and limitations as well as economics involved in surface engineering.

CO4: Articulate the various causes and the possible remedies of the failed components. Moreover, the students will be able to re-work over failed components and understand the need and importance of repair welding.

CO5: To get familiar with the characteristics of the different materials used in repair and reclamation. Understand the various repair and reclamation welding procedures/techniques with specific case studies.

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):															
COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	1	1	1	1	1	3	2	3
CO2	3	3	2	3	2	1	1	1	1	1	1	1	3	2	3
CO3	3	3	2	2	2	1	1	1	1	1	1	1	3	2	3
CO4	3	2	2	2	2	2	2	1	1	1	1	1	3	2	3
CO5	3	3	2	2	2	2	2	1	1	1	1	1	2	2	2
Avg.	3	2.8	2	2.2	2	1.4	1.4	1	1	1	1	1	2.8	2	2.8

Theory:

Course Description	**Lecture**
Unit-I	
Introduction Need and requirement, Engineering aspects of surface engineering, Surfacing- introduction, hardfacing, cladding, build up and buttering; Some of the common surfacing applications- steel plants, power plants, earth moving equipment, agricultural implements, chemical & petrochemical industries, etc.	**8**
Welding Processes/Techniques for surfacing: Capabilities of various processes with respect to surfacing and recent developments in these; concept of weld cladding, various techniques used for cladding, cladding materials, areas of applications; various thermal spraying techniques, spraying materials along with applications; use of different surface coatings along with areas of applications	**8**
Surfacing Materials: Types of surfacing alloys- Iron based alloys, nickel-based alloys, chromium based alloys, cobalt based alloys and copper based alloys; their characteristics; factors to be considered in selection of surfacing alloys.	**8**
Unit 2	
Repair welding	**8**

Need of repair welding - techno-economics aspects, repair welding procedures for components made of steel casting and cast iron, cast iron repair, classification of repair welding procedures according to the size. Some general examples of repair welding viz. Connecting rod, iron pulley, iron plate, shafts or carriage wheels etc.	
Repair Welding for specific applications: Damaged bends in gas transmission pipeline, heat exchanger repair techniques-explosive expansion, plugging, etc., creep damaged high temperature components, repair of cracked petroleum pressure vessel/reactor.	**10**
Temper bead welding: Special procedures to avoid post-repair stress relief heat treatments; half bead, temper bead techniques, usage of different alloys filler metals	**6**

Total=48

Text Books:

1. Dobly R.E., Kent K.S., 'Repair and Reclamation', The Welding Institute, 1986
2. Maintenance Welding in Nuclear Power Plants, American Welding Society, 1988.
3. Recommended Practice for Repair welding and Fabrication Welding of Steel Casting, Steel Foundry Research Foundation , 1981.
4. Lim Cottrel C., The Welding Institute, 'Welding Cast Irons', 1991.
5. Weld Surfacing and Hardfacing. The Welding Institute, 1987.
6. Nagendra Reddy A., 'Maintenance Welding Made Easy', Jaico Publishing House, 1997

Subject Code : PCME 823
Title of the course : MODELING AND SIMULATION LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Identify the underlying concepts; advantages, limitations and usefulness of modeling & simulation of engineering systems in general, and that of manufacturing systems in particular**.**
CO2: Construct mathematical model for continuous and discrete engineering systems.
CO3: Obtain random samples by generating & testing random numbers [0, 1], and converting to random variates as per appropriate statistical (probability) distribution.
CO4: Simulate the problems of manufacturing systems and management science using appropriate set of random samples.
CO5: Design the simulation experiment for static, dynamic and stochastic systems.

CO/PO Mapping: Strong(3) / Medium(2) / Weak(1) indicates strength of correlation:															
Cos	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	3	3	2	2	2	1	1	2	3	1	1	1
CO2	2	2	3	3	3	2	2	2	1	1	2	3	1	2	1
CO3	2	2	3	3	3	2	2	2	1	1	2	3	2	2	2
CO4	2	2	3	3	3	2	2	2	1	1	2	3	2	3	3
CO5	2	2	3	3	3	2	2	2	1	1	2	3	1	1	2
Avg.	2	2	3	3	3	2	2	2	1	1	2	3	1.4	1.8	1.8

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Develop a mathematical model for the pure pursuit problem involving an object A chasing (at a constant speed) the object B moving with predetermined path in a two-dimensional space. Obtain the simulation in results in MatLAB.
2.	Develop a mathematical model for the pursuit problem involving an object A chasing (at a constant speed) the object B moving on a path changing the direction of motion randomly in a two-dimensional space. Obtain the simulation in results in MatLAB.
3.	Develop a mathematical model for simulation of a serial chase problem involving four object A, B, C and D located at 4-vortex of a square, chasing each other with same uniform velocity. Obtain the simulation in results in MatLAB.
4.	Develop a mathematical model for simulation of path of a projectile, considering air resistance to be proportional to some power of velocity (v^n). Obtain the simulation in results in MatLAB considering (a) g to be constant, (b) g to be variable.
5.	Develop a mathematical model for simulation of a chemical reactor problem involving three products A, B, C reacting together, with 1 gm each producing the 3 gm of the product D in forward reaction, and decomposition in the reverse reaction. Obtain the simulation in results in MatLAB
6.	Attempt the following using MatLAB.

	a. Develop a set of 500 IID R[0, 1] using linear congruential method. b. Conduct a test for (i) uniformity, and (ii) statistical independence. c. Generate a set of random variates for (i) N(10, 2), and (ii) Exp(5).
7.	Develop a simulation model for change in population in the country considering various real world factors. Obtain the simulation in results in MatLAB.
8.	Develop a simulation model for a (i) single server, (b) double server, (c) 3-server queue for a railway reservation problem, involving complex arrivals and service times with balking, reneging and jockeying. Obtain the simulation in results in MatLAB
9.	Develop a simulation model for (a) an inventory system, (b) demand forecast. Obtain the simulation in results in MatLAB.
10.	Develop a simulation model for obtaining the criticality index of various paths (sequence of activities) for completion of the project for a given PERT problem using MatLAB.

Subject Code : PCME-824
Title of the course : COMPUTER INTEGRATED MANUFACTURING LAB

L	T	P	Credits	Weekly Load
0	0	0	2	4

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Apply CAM in real life application
CO2: Apply G codes and M codes for CNC programming
CO3: Utilize different software modules to manage the industrial data
CO4: Develop the knowledge of modern quality check-up.
CO5: Modernization ways enhancement.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	1	3	3	3	2
CO2	3	3	3	2	2	3	3	1	3	3	3	2
CO3	3	2	3	1	3	3	3	1	3	2	3	2
CO4	2	2	2	3	3	1	2	1	3	2	3	2
CO5	3	3	2	1	3	2	3	1	3	3	2	3
Avg.	2.8	2.6	2.6	1.8	2.8	2.4	2.8	1	3	2.6	2.8	2.2

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Fabrication and testing of setup for cutting force measurement using strain gauge.
2.	Fabrication and testing of setup for cutting force measurement using piezoelectric crystal.
3.	Fabrication of displacement measurement system using proximity sensor.
4.	Development and testing of digital encoder.
5.	Development of circuitry and its testing for cutting tool temp. measurement using thermocouples.
6.	System design and testing for tracking of light source or LED movement on a shop floor
7.	Design and fabrication of RPM measurement instrument (contact type and non-contact type).
8.	Programming and making job on CNC lathe machine.
9.	Programming and making job on CNC milling machine.
10.	Development and testing of unidirectional conveyor system.

Subject Code : **PEME-823(A)**
Title of the course : **ADDITIVE MANUFACTURING LAB**

L	T	P	Credits	Weekly Load
0	**0**	**2**	**1**	**2**

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Learn what Advanced/Additive manufacturing (AM) is and understand why it has become one of the most important technology trends in decades for product development and innovation.

CO2: Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available. •

CO3: To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies

CO4: Articulate the various trade-offs that must be made in selecting advanced/additive manufacturing processes, devices and materials to suit particular product requirements.

CO5: To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	3	3	1	3	3	1	3	3
CO2	3	3	3	2	3	3	2	1	2	2	3	3
CO3	3	3	3	1	3	2	3	3	3	3	2	3
CO4	3	3	2	3	1	2	2	3	3	3	1	3
CO5	3	2	1	3	3	1	3	1	3	3	3	3
Avg.	3	2.6	2	2.4	2.6	2.2	2.2	2.2	2.8	2.4	2.4	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Geometric model: CAD
2.	Free-form 3d model
3.	Reverse Engineering: Introduction
4.	Reverse Engineering: From Scanner to Model validation
5.	Additive Manufacturing Process Plan: Building Strategies
6.	Additive Manufacturing Process Plan: Post Processing
7.	Development of Additive Manufacturing Technology
8.	Extrusion Based Additive Manufacturing Process
9.	Powder bed fusion and material jetting Additive Manufacturing Process Project Group Meeting
10.	Additive manufacturing in medical applications and Bio-manufacturing

Subject Code : PEME-823 (B)
Title of the course : COMPUTER AIDED DESIGN (CAD) LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Create the different wireframe primitives using parametric representations.
CO2: Create surface primitives using parametric modeling.
CO3: Create the different solid primitives using the different representation schemes.
CO4: Apply geometric transformations on the created wireframe, surface and solid models.
CO5: Impart advanced education in the fields of design

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	3	1	3	2	1	3
CO2	3	3	3	2	3	1	2	1	3	2	3	3
CO3	3	2	3	2	2	1	2	1	3	2	3	3
CO4	3	3	3	2	3	3	2	2	3	2	3	3
CO5	1	2	1	2	1	3	1	3	2	2	3	3
Avg.	2.6	2.6	2.6	2	2.4	1.8	2	1.6	2.8	2	2.6	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	Introduction and Installation of CAD/CAE Softwares
2.	Introduction to Solid Modelling & Pro/E Package
3.	Introduction to MATLAB Programming
4.	Working with advanced modeling tools (Sweep, Blend & Swept Blend)
5.	Assembly modelling in Pro/E
6.	Generating, editing and modifying drawings in Pro/E
7.	Creating an assembly, moving components, wire frame and surface geometry.
8.	Generating of ferguson's cubic surface patches, Bezier surface patches and coons patches
9.	Exercises on Analytic Curves (Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics) using MATLAB Pr ogramming
10.	Exercises on Synthetic Curves (Cubic Spines, Bezier Cures, B-Spine Curves) using MATLAB Programming

Subject Code : PEME-823 (C)
Title of the course : PRODUCT DESIGN AND DEVELOPMENT LAB

L	T	P	Credits	Weekly Load
0	0	2	1	2

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the prerequisites of the product design & development, concept of product life cycle, including PLM framework, product data management, system integration and quality issues.
CO2: Apply the concept of value engineering and value analysis to product design & development.
CO3: Understand the underlying issues on material and process selection for product design & development.
CO4: Apply the concept of design for manufacture and assembly, incorporating other life cycle issues at the design stage.
CO5: Understand the principles of engineering ethics and liability issues; and apply the basic tools of design protection.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	3	3	3	2	3	3
CO2	3	3	3	2	3	3	1	1	2	2	3	3
CO3	3	1	2	2	2	3	3	1	2	2	3	3
CO4	3	3	1	2	3	2	2	1	3	3	3	3
CO5	1	2	3	2	2	3	2	3	3	3	3	3
Avg.	2.6	2.4	2.4	2	2.4	2.4	2.2	1.8	2.6	2.4	3	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study activities and experimental techniques in product design and process development
2.	Implementation of Steps in product design and process development (A case study).
3.	To study basic costs for producing and distributing a product (A case study).
4.	To perform process development: allocation of time and effort for different products.
5.	To expose the students to different applications of simulation and analysis by using FEA Packages like ANSYS etc.
6.	A case study of Product launch and evaluation
7.	Case Study: Consumer Expectations of the Automobile Industry
8.	To expose the students to carryout detailed design calculations and analysis of any mechanical component or mechanical system
9.	To integrate the parts design with assembly and to prepare manufacturing drawings.
10.	To study product commercialisation: coordination of resources and project timing

Subject Code : PEME-911 (A)
Title of the course : QUALITY MANAGEMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Apply various 7 QC tools in practical applications.
CO2: Conduct quality performance measurements of any firm
CO3: Apply the QFD technique in product development
CO4: Conduct of Quality Audit and Reporting in an organization.
CO5: Select statistical tools of quality control tools.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	3
CO2	3	3	3	3	3	1	1	1	1	1	1	3
CO3	3	3	3	3	3	1	1	1	1	1	1	3
CO4	3	3	3	3	3	1	1	1	1	1	1	3
CO5	3	3	3	3	3	1	1	1	1	1	1	3
Avg.	3	3	3	3	3	1	1	1	1	1	1	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**8**
Attributes of Quality, Evolution of Philosophy of Quality Management	
Total Quality Management	**8**
Quality Assurance and Total Quality Management, Models of Quality Management, Customer Value Enhancement, Product Quality Improvement	
Unit-II	
Quality Improvement Tools	**20**
QFD, Taguchi Methods, 7 QC tools, Statistical Process Control, Acceptance Sampling, Service Quality, Tools and Techniques of Service Quality Improvement, Quality Costs, Strategic Quality Planning, Quality in Non-Manufacturing Activities: Finance, Marketing, Human Resource Management, Administration, Quality System Implementation	
Quality Management Systems	
ISO 9000, Quality Information Systems, ISO 14000, Quality Audit & Reporting, Human Resource Management in TQM Environment, Case Studies	**12**
	Total=48

Text Books:

1. S.P.Singh, Vikas, Production and Operation Management, Publishers, Delhi
2. Grant & Leave worth, Statistical Quality Control, McGraw Hill
3. J.R. Taylor, Quality Control Systems, McGraw-Hill
4. M.Mhajan, Statistical Quality Control, Dhanpat Rai.
5. A.V. Taylor, Total Quality Control, McGraw-Hill.
6. Ravi Shankar, Industrial Engineering & Management, McGraw-Hill
7. Arvind Jayant, Industrial Engineering & Operation Management, Stadium International Press

Subject Code :PEME-911(B)
Title of the course :SUPPLY CHAIN MANAGEMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Knowledge gain about supply chain management concept
CO2: Conduct performance measurements of any supply chain.
CO3: Capable to apply the SCM philosophy in the industry.
CO4: Conduct of inventory management at inbound & outbound supply chain level
CO5: Understand the framework and scope of supply chain networks andfunctions.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	2	1	3	2	3	3
CO2	3	3	3	3	3	1	2	2	2	2	3	3
CO3	3	3	3	3	3	1	2	1	3	3	2	3
CO4	3	3	3	3	3	2	1	2	2	3	2	3
CO5	3	3	3	3	3	2	1	1	1	3	2	3
Avg.	3	3	3	3	3	1.4	1.6	1.4	2.2	2.6	2.4	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**12**
Role of Logistics and Supply chain Management: Scope and Importance, Evolution of Supply Chain, Decision Phases in Supply Chain, Competitive and Supply chain Strategies, Drivers of Supply Chain Performance and Obstacles.	
Supply Chain Network Design	**12**
Role of Distribution in Supply Chain, Factors influencing Distribution network design, Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain, Framework for network Decisions	
Unit-II	
Logistics in Supply Chain	**08**
Role of transportation in supply chain, factors affecting transportations decision, Design option for transportation network, Tailored transportation, Routing and scheduling in transportation	
Sourcing and Coordination in Supply Chain	**08**
Role of sourcing supply chain supplier selection assessment and contracts, Design Collaboration, sourcing planning and analysis, supply chain co-ordination, Bull whip effect. Effect of lack of co-ordination in supply chain and obstacles, Building strategic partnerships and trust within a supply chain	
Supply Chain and Information Technology	**08**
The role IT in supply chain, The supply chain IT frame work, Customer Relationship Management Internal supply chain management, supplier relationship management, future of IT in supply chain, E-Business in supply chain	

Total=48

Text Books:

1. Sunil Chopra, Peter meindl and Kalra, Supply Chain Management, Strategy, Planning,and operation, Pearson Education, 2010.

2. Srinivasan G.S, Quantitative models in Operations and Supply Chain Management, PHI, 2010.
3. James B.Ayers, Handbook of Supply chain management, St.Lucle press, 2000.

Subject Code : PEME-911C
Title of the course : PROCESSING OF COMPOSITE

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOME:

After learning the course, the students should be able to:

CO 1: Understand the significance of replacing existing metal structures with composite materials wherever beneficial

CO 2: Highlight the appropriate use of composite structures in the industry

CO 3: Comprehend the complexity of design of composite materials and structures

CO 4: Mainly understand the mechanics of composite materials

CO 5: Students would have fundamental knowledge in mechanical analysis and design of structures made of composite materials.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	1	2	3	2	3	2	3	3
CO2	3	3	2	1	1	2	3	2	3	3	2	2
CO3	3	3	3	2	2	1	3	1	2	3	3	2
CO4	2	3	2	1	1	1	2	1	1	2	2	2
CO5	2	1	1	3	2	2	2	1	2	2	2	3
Avg.	2.6	2.6	1.8	2	1.4	1.6	2.6	1.4	2.2	2.4	2.4	2.4

Theory

Course Description	**Lecture**
Unit-I	
Introduction to Composite Materials	**6**
Definitions: Composite material, Fiber, Matrix. Types of fibers and Raw Fiber Properties, Types of Matrix, Prepegs, Fillers and other Additives, Advantages of Composite Materials and Structures. Applications and Use of Composite materials in present world	
Basics of composites	**4**
Mechanical Behavior of Composite Materials. Lamina, Laminate: The basic building block of a composite material	
Micromechanical Analysis of Composite Strength and Stiffness	**8**
Properties of typical composite materials. Volume and Weight Fractions. Longitudinal Strength and Stiffness. Transverse Modulus. In-plane shear Modulus. Poisson's ratio	
Elastic Properties of the Unidirectional Lamina	**6**
Stress-strain relationships. Engineering Constants. Stress strain relations of a Thin Lamina. Examples	
Unit-II	
Analysis of Laminated Composites	**8**
Laminates, Basic Assumptions, Strain-Displacement Relationship, Stress-Strain Relationships, Equilibrium Equations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration, Balanced Laminate, Anti-symmetric Laminate, Examples	
Fracture & Safety of Composite	**10**
Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle	

matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementary reliability analysis.	

Total=48

Text Books:

1. Agarwal, B.D. and Broutman, L.J., "Analysis and Performance of Fibre Composites", 3rd Ed., John Wiley & Sons.
2. Jones, R.M., "Mechanics of Composite Materials", Taylor & Francis.
3. Ashbee, K.H.G. and Ashbee, H.G., "Fundamental Principles of Fibre Reinforced Composites", 2nd Ed., CRC Press.
4. Daniel, I.M. and Ishai, O., "Engineering Mechanics of Composite Materials", 2nd Ed., Oxford University Press.
5. Christensen, R.M., "Mechanics of Composite Materials", Dover Publications.
6. Kaw, A. K., "Mechanics of Composite Materials", 2nd Ed., CRC Press.

Subject Code : PEME 911 (D)
Title of the course : PHYSICS OF WELDING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Learn and understand different physical properties of fluids at elevated temperatures.
CO2: Learn and understand the concept of electricity and magnetism.
CO3: Learn and understand about the basic concepts of fluid and magneto fluid dynamics and apply this fundamental knowledge for understanding electric arc in welding.
CO4: Learn about metal transfer and mass flow in the weld pool and apply this knowledge for understanding its implications on the weld strength.
CO5: Learn and understand the concept of high power density welding.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	3	3	2	1	1	1	3
CO2	3	3	3	2	2	2	2	1	3	2	2	3
CO3	3	3	3	2	3	3	3	1	2	1	3	3
CO4	3	3	3	3	2	2	3	1	2	3	2	3
CO5	3	3	3	2	2	2	2	3	2	1	2	3
Avg.	3	3	3	2.2	2.4	2.4	2.6	1.6	2	1.6	2	3

Course Description	**Lecture**
UNIT-I	
Physical Properties of Fluids at Elevated Temperatures	**6**
Introduction, gases, dissociation and ionization, the equation of state of a gas at elevated temperature, the equilibrium constant, evaluating the degree of dissociation and ionization, specific heat, transport phenomena, particle encounters in a slightly ionized gas, particle encounters in an highly ionized plasma, electrical conductivity, thermal conductivity, viscosity, calculating the transport coefficients, liquid metals, vapour pressure, surface tension, viscosity.	
Electricity and Magnetism	**6**
Fundamentals like Electrons and ions, electrostatics, Gauss's law, the magnetic force, the law of Biot and Savart, electromagnetic induction, the Maxwell stress and the force on a conducting body, the force acting on a liquid drop carrying an electric current, the current density and ohms law, the pinch instability: an approximate solution, the dynamics of instability in fluid cylinder, predicted behaviour of perturbed cylinder: radial pinch, higher unstable modes, the effect of an externally applied magnetic field, the growth rate constant, the effect of viscosity on the instability of a fluid cylinder.	
Fluid and Magneto Fluid Dynamics	**6**
Introduction, the continuity equation, the momentum equation, momentum, pressure, viscosity, Lorentz force, other forces, and the equilibrium condition, the stream function, the components of stress, the Bernoulli equation, solutions of the momentum equation, laminar flow from a point source of momentum with no electric current: the steady jet, the fluid pressure in the jet, the steady jet with a heat source, laminar flow from a point source in a semi-infinite fluid (no electric current), laminar flow in a semi-infinite fluid having a point source of current in the plane ($\theta=\pi/2$), laminar flow in a semi-infinite fluid: the linear solution, the time-dependent development of flow due to a point source of current in a semi-infinite region, breakdown of the solution to the non-linear problem, other	

limitations to analytical solutions of the momentum equation, laminar flow in a liquid drop immersed in a conducting fluid carrying an electric current, distortion of the liquid drop, an ellipsoid of revolution in a conducting fluid: the drag coefficient, laminar flow in a hemisphere having a point source of current at the origin, flow in a container induced by a distributed current source.	
The Electric Arc	**6**
Introduction, general description of glow and arc discharges, principal characteristics of the electrode regions of arcs, high electric and thermal fields, contraction, classification based on degree of contraction: range of observed current density, glow and arc cathode; glow and arc plasma; glow and arc cathode and abode falls, distinction between thermionic and non-thermionic cathodes, the lo voltage non-thermionic cathode, surface clean up and movement in magnetic field including retrograde motion, vapour and plasma jets; force on cathode, electrode material and surface state, mature of gas or vapour, value of current, gas pressure; vacuum arcs, theories of the cathode mechanism, the glow cathode: the thermionic cathode, theories of the non-thermionic cathode, the arc column, the anode, theory of glow anode, anode fall voltage and current density, energy balance at the anode, plasma and vapour jets.	
Unit-II	
The Electric Arc in Welding	**8**
Introduction, structural features, overall electrical characteristics, the total arc characteristics at various pressures, relationship between power source and arc characteristics, arc efficiency, cathode phenomena, cathode phenomena, cathode phenomena and characteristics: thermionic cathodes, the potential drop adjacent to a thermionic cathode, cathode phenomena and characteristics: non-thermionic cathodes, anode phenomena, anode characteristics, the anode at the tip of the rod, the heat balance at the anode, the depth of the anode drop zone, the arc column, the energy flux in the arc column, the ac column temperature, mass flow in the arc column, the effect of pressure variation on the arc column, calculating mass and heat flow in the arc column, arc stiffness and arc blow, controlling arc stiffness and arc force.	
Metal Transfer and Mass Flow in the Weld Pool	**8**
Metal transfer, introduction, the effect of static forces in drop detachment, the pinch instability in GMA welding, other unstable modes, the burn off rate, the drop temperature, the drop transfer rate, the pinch model applied to the droplet transfer rate, transfer of drops across the arc, the arc force, the weld pool, flow in the weld pool, the weld pool temperature, the shape of the weld pool and the reinforcement bead, the effect of composition and surface condition on the shape of the weld pool.	
High Power Density Welding	**8**
Introduction, keyholing, range of power densities in welding processes (a) high power densities, (b) intermediate power densities, (c) & (d) low power densities, threshold power density for vaporization, size of the keyhole, discussion on forces acting within the keyhole, forces tending to form and maintain the keyhole like beam pressure, vapour pressure, recoil pressure, ; forces tending to close the keyhole like Gravitational pressure, Surface tension pressure, pressure balances for a generalised keyhole a) bottom of the keyhole (closed), b) sides of the keyhole, moving weld pool.	

Total=48

Text Books:

1. The Physics of Welding by J. F. Lancaster, Publisher: Pargamon Press.
2. Advanced joining technologies by T. W. Eager, Publisher: Chapman & Hall

Subject Code : PEME-911(E)
Title of the course : WELDABILITY OF ENGINEERING MATERIALS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1:. Understand the concept of weldablity.
CO2: Understand various problems related to weldability.

CO3: Learn basic principles and methods utilized for testing weldability.
CO4: Apply the knowledge of weldability for various material alloy systems that are commonly used in commercial welding and manufacturing.
CO5: Apply the knowledge and skill for improvement of weldability for various materials.

Pre-requisite knowledg

CO/PO Mapping: (Strong(3) / Medium(2) / Weak(1) indicates strength of correlation):

COs	Programme Outcomes (POs)												Programme Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PS O2	PS O3
CO1	2	2	1	1	1	1	1	1	1	1	-	1	1	-	1
CO2	3	3	2	2	2	1	1	1	1	1	-	1	2	-	1
CO3	3	3	3	3	3	1	1	1	1	1	3	3	3	2	3
CO4	3	3	3	3	3	2	2	1	1	1	3	3	3	2	3
CO5	3	3	3	3	3	2	2	1	1	1	3	3	3	2	3
Avg.	2.8	2.8	2.4	2.4	2.4	1.4	1.4	1	1	1	1.8	2.2	2.4	1.2	2.2

Theory

Course Description	Lecture(s)
Unit-I	
Weldablity	**06**
Concept, factors effecting weldablity, weldablity tests, Hot and cold cracking tests.	
Weldablity of cast irons	**06**
Welding issues related to cast irons (Gray cast iron, white cast iron and malleable cast iron).	
Weldablity of carbon steels	**06**
Weldablity of low carbon steel, medium carbon steels and high carbon steels.	
Weldablity of stainless steels	**06**
Weldablity of austenitic, ferritic, martensitic stainless steels.	
Unit-II	
Weldablity of copper and its alloys	**06**
Weldablity factors, welding of copper and its alloys, brazing and soldering of copper and its alloys	
Weldablity of aluminium and its alloys	**06**
Welding of aluminium and its alloys (GTAW and GMAW), problems associated with welding of aluminium.	
Weldablity of magnesium and nickel alloys	**08**
Welding of magnesium and nickel alloys, problem associated with welding of these alloys.	
Welding of plastics	**04**

Weldablity of engineering plastics, fabrication techniques.	

Total=48

Text Books:

1. R. S. Parmar, Welding Engineering & Technology, Khanna Publications.
2. S. V. Nadkarni, Modern Arc Welding Technology, Oxford & IBH.
3. Leonard. P. Connor, AWS Welding Handbook, Volume-1, AWS.
4. IS-3600 (Part-I & II), Method of Testing Fusion Welded, BIS, New Delhi.
5. O P Khanna, Joints and Weld Metals in Steel Welding Technology, Dhanpat Rai

Subject Code : PEME-911 (F)
Title of the course : FLEXIBLE MANUFACTURING SYSTEMS (FMS)

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the importance of Flexibility in manufacturing systems.

CO2: Analyze the different types of manufacturing systems and different equipments involved in these systems.

CO3: Learn, understand, identify and predict about different types of design and opearional problems in these manufacturing systems.

CO4: Understand the concept of .group technology.

CO5: Learn, calculate the solution methodology of FMS related manufacturing issues

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	3	2	1	1	3	1	3
CO2	3	3	3	3	2	3	3	1	1	2	1	3
CO3	3	2	1	3	2	2	3	2	2	2	1	2
CO4	2	3	1	2	3	3	3	1	1	2	1	3
CO5	3	3	3	3	2	3	2	1	1	3	1	2
Avg.	2.6	2.8	2.2	2.6	2.2	2.8	2.6	1.2	1.2	2.4	1	2.6

Course Description	**Lecture(s)**
Unit-I	
Introduction	**10**
FMS definition and classification of manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.	
FMS Equipment	**14**
Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment	
Unit-II	
Group Technology	**08**
GT concepts, Advantages of GT, Part family formation-coding and classification systems; Partmachine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.	
FMS related problem and Solution Methodology	**14**
FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks. FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns	

Total=48

Text Books:

1. Groover Englewood, Automation, Production System & Computer Integrated Manufacturing
2. Rankey, Design and Operation of SMS, IFS
3. Wernecks, Flexible Manufacturing System, Spring Verlag.
4. Bonctto Northox, FMS in Practice, Ford
5. W.W. Luggen, Flexible Manufacturing Cells and systems, Prentice Hall India.
6. Vishwanathan & Narahari, Performance Modelling of Automated Manufacturing Systems, Prentice Hall India

OPEN ELECTIVE

Subject Code : OEME-911 (A)
Title of the course : INDUSTRIAL ENGINEERING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Understand the basic concept of Production and Industrial engineering.
CO2: Develop and prepare various recording techniques associate with work study/ method study.
CO3: Able to apply various techniques for optimum utilization of resources.
CO4: Able to practical apply inventory control model.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	1	2	2	3	3
CO2	3	3	3	3	2	3	1	3	3	2	2	3
CO3	3	3	3	3	3	3	2	2	3	3	1	3
CO4	3	3	3	3	2	2	2	3	2	1	3	3
Avg.	3	3	3	3	2.5	2.5	1.5	2.25	2.5	2	2.25	3

Theory

Course Description	**Lecture(s)**
Unit-I	
Introduction	8
Industrial Engineering, Definition and Evolution, Understanding Industrial System Focus: Production/Service System. Performance measures of a Production System -Production, Productivity, Efficiency, Effectiveness, Classical Industrial Engineering -Work Study: Method Study and Time Study, Human Factors, Ergonomics.	
Quality Control	**8**
Quality, TQM, SQC, Control Charts, Acceptance Quality Level (AQL), Lot Tolerance Percentage Defective (LTPD), Producer's Risk, Consumer's Risk, Operating Characteristic Curve, Simple Numerical Problems	
Value Engineering	**8**
Concept of value analysis, Aim and objectives, Phases in value analysis, Test for value analysis, Difference between V.E. and Cost Reduction Techniques, Functional Analysis System Techniques (FAST), Principles of Value Analysis.	
Unit-II	
Production and Process Planning	**8**
Objectives of PPC, Component of PPC, Phases of PPC, Process Planning, Steps in Process Planning for Flow Shop Scheduling, Types of Scheduling Systems, Master Scheduling, Order Scheduling, Comparison between Production Planning and Production Control, Sequencing. **Reliability and Maintenance**	
Reliability, availability and maintainability; distribution of failure and repair times; determination of MTBF and MTTR, reliability models; system reliability determination; preventive maintenance and replacement, total productive maintenance – concept and applications.	**8**
Production Planning and Inventory Control	**8**
Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP-II and ERP; order control and flow control; routing, scheduling and priority dispatching; push and pull production systems, concept of JIT manufacturing system;	

logistics, distribution, and supply chain management; Inventory – functions, costs, classifications, deterministic and probabilistic inventory models, quantity discount; perpetual and periodic inventory control systems.	

Total=48

Text Books:

1. A. Barnes, Motion and Time Study, John Wiley & sons.
2. Dalela and Sourabh, Work Study and Ergonomics, Standard Publishers.
3. Ronald Mayer, Production Management, TMH.
4. Martand Telsang, Industrial Engineering & Management, S.Chand

Subject Code : OEME-911 (B)
Title of the course : ROBOTICS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

CO1: Obtain knowledge and understand the basic concepts of industrial robotics, namely in terms of classification, kinematics, sensors, and typical applications
CO2: Understand the control techniques used for rehabilitation robots, namely force control
CO3: To acquire the knowledge on advanced algebraic tools for the description of motion
CO4: Design and implement control applications for autonomous mobile robots.
CO5: Understanding the dynamics of the manipulator.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	1	2	2	1	2	1	3
CO2	3	3	3	2	1	2	3	3	2	2	2	2
CO3	3	2	2	3	1	2	3	2	1	2	3	3
CO4	3	2	3	3	3	3	3	2	2	3	3	3
CO5	3	3	3	3	3	3	3	2	2	2	3	3
Avg.	3	2.6	2.8	2.4	2.2	2.2	2.8	2.2	1.6	2.2	2.4	2.8

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	04
Evolution of robot and robotics, laws of robotics, robot anatomy: Links, joints, Degrees of freedom (DOF), Arm configuration, wrist configuration, end-effector.	
Coordinate Frame, Mapping and Transforms	08
Coordinate frames, description of objects in space, transformation of vectors, inverting a homogeneous transform, fundamental rotation matrices	
Kinematics	12
Denavit- Hartenberg Notation, kinematic relationship between adjacent links, Manipulator transformation matrix, Inverse kinematics. Linear and angular velocity of a rigid body, velocity propagation along links, manipulator jacobian	
Unit-II	
Dynamics	12
Two DOF manipulator- Dynamic Model, Lagrange-Euler Formulation: Velocity of a point on the manipulator, equation of motion, LE Dynamic Model algorithm, Newton-Euler Formulation: Newton equation, Euler's equation, Comparison of Lagrange-Euler and Newton-Euler Formulation	
Control of manipulators	12
Robot control problems, Robotic Control strategies like PD, PID, computed torque control, Position control, force and impedance control Applications of standard control strategies. A METLAB tutorial on using the package for Robotics	
	Total=48

Text Books:

1. Mittal and Nagrath, Robotics and Control, TMH.
2. J.J. Craig, Introduction to Robotics, Pearson Education.
3. Beer and Johnston, Vector mechanics, TMH.
4. Nise, Control System Engineering,Wiley.

Subject Code : OEME- 911 (C)
Title of the course : DESIGN OF EXPERIMENTS

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to:

CO1: Understand the basic concepts of optimization.
CO2: Understand the basic concepts of experimentation analysis like selection of random variables.
CO3: Construct mathematical model for random phenomena like Null Hypothesis and Alternative Hypothesis.
CO4: Obtain engineering solutions based on statistical analysis like Factorial Design and Taguchi Method.
CO5: Analyze the variance like one-way ANOVA, two ways ANOVA, numerical on ANOVA, Z-test and T test

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	3	2	1	2
CO2	3	3	3	3	2	1	2	1	2	2	1	2
CO3	3	3	3	3	2	2	2	1	3	2	2	2
CO4	3	3	3	3	2	3	3	1	2	2	2	3
CO5	3	3	3	3	2	2	3	1	3	3	3	3
Avg.	3	3	3	3	2	1.8	2.2	1	2.6	2.2	1.8	2.4

Theory

Course Description	**Lecture**
Unit-I	
Introduction	**08**
Brief introduction of optimization techniques, Strategy of experimentation, Basic principles of Design, Terminology used in Design of Experiment, Guidelines for designing experiments, Basic statistical concepts: Types of Data, Graphical representation of Data, Measures of Central Tendency and Dispersion, Skewness.	
Simple Comparative Experiments	**08**
Sampling and sampling Distribution, Test of significance for single mean and for difference of means of two samples, Inferences about the Differences in means: randomized designs, Inferences about the Differences in means: Paired comparison Designs, Inferences about the Variances of Normal Distributions. Test of significance based on t, F and Chi square distribution.	
Fitting Regression Models	**08**
Introduction, Linear regression models, Estimate of parameters in linear regression models, The method of least square, Hypothesis testing: Null Hypothesis, Alternative Hypothesis, Prediction of new response observations, Testing for lack of fit.	
Unit-II	
Factorial Design	**08**
Basic definition and principles, Advantages of factorials, Types of factorial design: Full factor factorial design and fraction factorial design, Design Matrix, Development of mathematical model, Regression model diagnostics.	
Taguchi method	**08**
Introduction, Concept design, Parameter design, Tolerance design, Orthogonal array experiments Taguchi quality loss function, Signal-to Noise ratio, Quality characteristics, Parameter optimization experiment, Parameter design case study.	
Analysis Of Variance (ANOVA)	**08**

Introduction, One-way ANOVA process, Two-way ANOVA process, Degrees of freedom, Case studies on Factorial design, Taguchi Method and ANOVA.	

Total=48

Text Books:

1. Douglas C Montgomery, Design and Analysis of Experiments, John Wiley
2. John P.W.M., Statistical Design and Analysis of Experiments, Macmillan,
3. Montgomery D.C., Runger G. C., Introduction to Linear Regression Analysis,
4. Taguchi, G., Introduction to Quality Engineering, Asian Productivity Organisation, UNIPUB, White Plains, New York
5. Taneja HC, Statistical Methods for Engineering and Sciences, IK International Publishing house Pvt Ltd.
6. J. Wesley Barnes, Statistical Analysis for Engineers and Scientists, McGraw Hill Inc.

Subject Code : OEME-911(D)
Title of the course : ADDITIVE MANUFACTURING

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: To apply knowledge leaned on AM and RE technologies for product development.

CO2: Demonstrate comprehensive knowledge of the broad range of AM processes, devices, capabilities and materials that are available. •

CO3: To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies

CO4: To analyse principles behind AM and RE techniques, and to be fluent in selecting additive manufacturing processes, devices and materials to suit product requirements.

CO5: To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	3	3	1	3	3	1	3	3
CO2	3	3	3	1	3	3	1	1	2	1	3	3
CO3	3	3	3	2	3	1	3	3	3	3	2	3
CO4	3	3	2	3	2	2	1	3	3	3	1	3
CO5	3	2	1	3	3	2	3	1	3	3	3	3
Avg.	3	2.6	2.2	2.4	2.8	2.2	1.8	2.2	2.8	2.2	2.4	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**10**
Additive Manufacturing: Overview, History, Need and Classification, Prototype Fundamentals, Additive Manufacturing Concepts in product development, Materials for Additive Manufacturing Technology, Data Interfacing for Additive Manufacturing.	
Liquid Based and Solid Based Additive Manufacturing Systems	**10**
Classification, Liquid based system, Stereolithography Apparatus (SLA): Principle, process, advantages and applications, Solid based system, Fused Deposition Modeling: Principle, process, advantages and applications, Laminated Object Manufacturing.	
Powder Based Additive Manufacturing Systems	**10**
Selective Laser Sintering: Principles, Process, advantages and applications, Three-Dimensional Printing: Principle, process, advantages and applications. Laser Engineered Net Shaping (LENS), Electron Beam Melting. Evaluation and Comparison of AM Technologies; AM Technologies in Research	
Unit 2	
Reverse Engineering	**12**
Introduction to Reverse Engineering, Data Capturing Technologies, Model Reconstruction, Data Processing for Additive Manufacturing Technology: CAD model preparation, Part Orientation and support generation, Model Slicing, Tool path Generation., RE-AM integration. Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.	
Additive Manufacturing and Reverse Engineering in Industrial Applications	**06**
Applications of Additive Manufacturing in Manufacturing and Tooling, Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Biomedical Applications of AM: Medical, Biomedical,	

Dental, Bio-printing, Tissue & Organ Engineering and many others- Computer Aided Tissue Engineering (CATE): Case studies.	

Total=48

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S, Rapid Prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2010.
2. C. K. Chua, and K. F. Leong, 3D Printing and Additive Manufacturing: Principles and Applications, 3rd Edition, World Scientific Publishing Company, 2014
3. K.G. Cooper, Rapid Prototyping Technology: Selection and Application, Marcel Dekker, 2001
4. Gebhardt A, Rapid prototyping, Hanser Gardener Publications, 2003.
5. Liou L.W. and Liou F.W, Rapid Prototyping and Engineering applications : A tool box for prototype development, CRC Press, 2007.
6. Kamrani A.K. and Nasr E.A, Rapid Prototyping: Theory and practice, Springer, 2006.
7. Hilton P.D. and Jacobs P.F, Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.
8. W.M. Steen, Laser Material Processing, 2nd Edition, Springer, 1998.

Journals and Magazines:

- Rapid Prototyping Journal, Emerald
- Computer Aided Design, Elsevier
- International Journal of Advanced Manufacturing Technology, Springer
- International Journal of Computer Integrated Manufacturing, Taylor and Francis
- Virtual and Physical Prototyping, Taylor and Francis.

Subject Code : OEME-911 (E)
Title of the course : COMPUTER AIDED DESIGN (CAD)

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Create the different wireframe primitives using parametric representations.
CO2: Create surface primitives using parametric modeling.
CO3: Create the different solid primitives using the different representation schemes.
CO4: Apply geometric transformations on the created wireframe, surface and solid models.
CO5: Impart advanced education in the fields of design

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	2	2	1	2	1	2	3
CO2	3	3	3	2	3	2	1	1	2	1	1	3
CO3	3	2	1	2	2	2	2	1	2	1	1	3
CO4	3	3	1	2	2	2	2	1	2	1	2	3
CO5	2	1	1	2	2	3	2	3	2	1	2	3
Avg.	2.8	2.4	1.8	2	2	2.2	1.8	1.4	2	1	1.6	3

Theory:

Course Description	**Lectures**
UNIT I	
Introduction	**06**
Definitions, Historical Development. Geometric Modeling, Nameable and Unnamable shapes, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.	
Design of Curves	**10**
Algebraic and Geometric Forms, Parametric space of a curve, Blending functions, Reparametrization, Truncating, Extending and subdividing, Space curve, Four point form, Straight lines, Spline Curves, Bezier Curves, B-spline Curves, Rational Polynomials, introduction to NURBS	
Design of Surfaces	**08**
Algebraic and Geometric form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Reparametrization of a surface patch, subdividing, Sixteen Point form, Four Curve Form, Plane surface, Cylindrical Surface, Ruled surface, Surface of Revolution. Bezier Surface, B-Spline Surface.	
UNIT II	
Solid Modeling Fundamentals	**08**
Topology of Closed Paths, Piecewise flat surfaces, topology of closed curved surfaces, Generalized Concept of boundary, Set theory, Boolean operators, Set-membership Classification, Euler operators, Formal Modeling Criteria, Constructive Solid Geometry, Boundary Representation.	
Transformations	**06**
Translation, Rotation, Scaling Symmetry and Reflection, Homogeneous Transformations. Orthographic Projections, Axonometric Projections, Oblique Projections, Perspective Transformation	
Introduction to Assembly-modeling	**05**

Introduction to assembly, Analytical Properties, Relational Properties and intersections, Data transfer formats.	
Applications	**05**
Implementation of the algorithms on MATLAB, Construction of Solid and Surface Models on any of the high end solid modelers (IDEAS / ProE and Imageware Surfacer).	

Total=48

Text Books:

1. Michael E. Mortension ,Geometric Modeling, John Wiley.
2. Zeid, I., CAD/CAM, McGraw Hill (2008).
3. Rogers, D. F. and Adams, J. A., Mathematical Elements for Computer Graphics, McGraw Hill (1989).
4. Rogers, D. F., Procedural Elements for Computer Graphics, McGraw Hill (2008).
5. Rooney, J. and Steadman, P., Principles of Computer Aided Design, prentice Hall (1988).
6. Rooney, J. and Steadman, P., Computer Aided Design, Pitman/Open University (1987).
7. Mallineuse, G., Computational Concepts and Methods, Kogan Page Ltd. (1986)

Subject Code : OEME-911 (F)
Title of the course : PRODUCT DESIGN AND DEVELOPMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Understand the prerequisites of the product design & development, concept of product life cycle, including PLM framework, product data management, system integration and quality issues.
CO2: Apply the concept of value engineering and value analysis to product design & development.
CO3: Understand the underlying issues on material and process selection for product design & development.
CO4: Apply the concept of design for manufacture and assembly, incorporating other life cycle issues at the design stage.
CO5: Understand the principles of engineering ethics and liability issues; and apply the basic tools of design protection.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	2	3	3	3	2	3
CO2	3	3	3	2	2	2	2	2	2	2	2	3
CO3	3	2	2	2	1	2	2	2	2	2	1	3
CO4	3	3	2	2	3	2	1	3	2	2	1	3
CO5	1	2	1	2	2	3	2	3	2	2	1	3
Avg.	2.6	2.6	2.2	2	2	2.4	1.8	2.6	2.2	2.2	1.4	3

Theory:

Course Description	Lecture
UNIT I	
Stages in Design process	**07**
Introduction to various stages of the design process: Identify Customer Needs, establish target specifications, Generate and Test Product concept, Final Specifications, Product architecture, Industrial Design, Case study.	
Product life cycle	**08**
New product introduction: early introduction, increased product life. Product Lifecycle Management: Product information, PLM framework, Enabling technologies, Product data management (PDM), Functions of PDM software. System integration, QFD, House of quality, Case studies.	
Value engineering	**05**
Introduction, nature and measurement of value, Value analysis job plan, Creativity and techniques of creativity, Value analysis test, Case studies	
Concurrent/ reverse engineering	**04**
Introduction, basic principles, components, benefits of concurrent engineering. Concept of reverse engineering.	
UNIT II	
Design for Manufacture	**06**
Product design for life-cycle, concurrent engineering, Design for Excellence (DFX), design for manufacture, rule-based and plan based DFM, automated manufacturability assessment, Automated manufacturability assessment.	
Product Assembly & Testing	**06**

Product design for a given need or identified need, Development and evaluation of multiple solutions and concepts, Manufacturability assessments of given design, Product Costing and Bill of Materials, Process planning for components and assembly, Product manufacturing and Testing. Establishing techno-economic feasibility product testing and *Management Studies* test marketing.	
Product Management	**07**
Commonly used DFX tools including, QFD, POKA YOKE, FMEA, Design for manual assembly and automated assembly, design for environment, Industrial and real-life case studies of DFX. product manager-functions and tasks-tools and techniques. Brand extensions, acquisitions, Brand value, Consumer insight. Strategies brand management.	
Patents, liability and ethics	**05**
Introduction, Protecting your design: patents, copyright, basic tools of design protection. Liability issues in product design. Ethical considerations, Examples/ case studies	

Total=48

Text Books:

1. Karl T. Ulrich, Steven D. Eppinger, Product Design & Development, Mc GrawHill.
2. John M. Usher, Utpal Roy and H. R. Parasaei, Integrated Product and Process Development, Tata McGraw Hill.
3. G. Boothroyd, P. Dewhurst and W. Knight, Product Design for Manufacture and Assembly, Marcel Dekker.
4. A. K. Chitale and R. C. Gupta, Product Design and Manufacture, PHI.
5. Mahmoud M. Farag, Selection of Materials and Manufacturing Processes for Engineering Design, Printice Hall.
6. M. F. Ashby, Material Selection in Mechanical Design, Elsevier.
7. Biren Prasad, Concurrent Engineering, Prentice Hall.

Subject Code : OEME-911 (G)
Title of the course : QUALITY MANAGEMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to

CO1: Apply various 7 QC tools in practical applications.
CO2: Conduct quality performance measurements of any firm
CO3: Apply the QFD technique in product development
CO4: Conduct of Quality Audit and Reporting in an organization.
CO5: Select statistical tools of quality control tools.

CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	3
CO2	3	3	3	3	3	1	1	1	1	1	1	3
CO3	3	3	3	3	3	1	1	1	1	1	1	3
CO4	3	3	3	3	3	1	1	1	1	1	1	3
CO5	3	3	3	3	3	1	1	1	1	1	1	3
Avg.	3	3	3	3	3	1	1	1	1	1	1	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**8**
Attributes of Quality, Evolution of Philosophy of Quality Management	
Total Quality Management	**8**
Quality Assurance and Total Quality Management, Models of Quality Management, Customer Value Enhancement, Product Quality Improvement	
Unit-II	
Quality Improvement Tools	**20**
QFD, Taguchi Methods, 7 QC tools, Statistical Process Control, Acceptance Sampling, Service Quality, Tools and Techniques of Service Quality Improvement, Quality Costs, Strategic Quality Planning, Quality in Non-Manufacturing Activities: Finance, Marketing, Human Resource Management, Administration, Quality System Implementation	
Quality Management Systems	
ISO 9000, Quality Information Systems, ISO 14000, Quality Audit & Reporting, Human Resource Management in TQM Environment, Case Studies	**12**
	Total=48

Text Books:

1. S.P.Singh, Vikas, Production and Operation Management, Publishers, Delhi
2. Grant & Leave worth, Statistical Quality Control, McGraw Hill
3. J.R. Taylor, Quality Control Systems, McGraw-Hill
4. M.Mhajan, Statistical Quality Control, Dhanpat Rai.
5. A.V. Taylor, Total Quality Control, McGraw-Hill.
6. Ravi Shankar, Industrial Engineering & Management, McGraw-Hill
7. Arvind Jayant, Industrial Engineering & Operation Management, Stadium International Press

Subject Code :OEME-911(H)
Title of the course :SUPPLY CHAIN MANAGEMENT

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Knowledge gain about supply chain management concept
CO2: Conduct performance measurements of any supply chain.
CO3: Capable to apply the SCM philosophy in the industry.
CO4: Conduct of inventory management at inbound & outbound supply chain level
CO5: Understand the framework and scope of supply chain networks andfunctions.

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	2	1	3	2	3	3
CO2	3	3	3	3	3	1	2	2	2	2	3	3
CO3	3	3	3	3	3	1	2	1	3	3	2	3
CO4	3	3	3	3	3	2	1	2	2	3	2	3
CO5	3	3	3	3	3	2	1	1	1	3	2	3
Avg.	3	3	3	3	3	1.4	1.6	1.4	2.2	2.6	2.4	3

Theory:

Course Description	**Lecture**
Unit-I	
Introduction	**12**
Role of Logistics and Supply chain Management: Scope and Importance, Evolution of Supply Chain, Decision Phases in Supply Chain, Competitive and Supply chain Strategies, Drivers of Supply Chain Performance and Obstacles.	
Supply Chain Network Design	**12**
Role of Distribution in Supply Chain, Factors influencing Distribution network design, Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain, Framework for network Decisions	
Unit-II	
Logistics in Supply Chain	**08**
Role of transportation in supply chain, factors affecting transportations decision, Design option for transportation network, Tailored transportation, Routing and scheduling in transportation	
Sourcing and Coordination in Supply Chain	**08**
Role of sourcing supply chain supplier selection assessment and contracts, Design Collaboration, sourcing planning and analysis, supply chain co-ordination, Bull whip effect. Effect of lack of co-ordination in supply chain and obstacles, Building strategic partnerships and trust within a supply chain	
Supply Chain and Information Technology	**08**
The role IT in supply chain, The supply chain IT frame work, Customer Relationship Management Internal supply chain management, supplier relationship management, future of IT in supply chain, E-Business in supply chain	

Total=48

Text Books:

1. Sunil Chopra, Peter meindl and Kalra, Supply Chain Management, Strategy, Planning,and operation, Pearson Education, 2010.
2. Srinivasan G.S, Quantitative models in Operations and Supply Chain Management, PHI, 2010.
3. James B.Ayers, Handbook of Supply chain management, St.Lucle press, 2000.

Subject Code : OEME-911 (I)
Title of the course : FLEXIBLE MANUFACTURING SYSTEMS (FMS)

L	T	P	Credits	Weekly Load
3	0	0	3	3

COURSE OUTCOMES:

After successful completion of course, the students should be able to

CO1: Understand the importance of Flexibility in manufacturing systems.

CO2: Analyze the different types of manufacturing systems and different equipments involved in these systems.

CO3: Learn, understand, identify and predict about different types of design and opearional problems in these manufacturing systems.

CO4: Understand the concept of .group technology.

CO5: Learn, calculate the solution methodology of FMS related manufacturing issues

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	2	3	2	1	1	3	1	3
CO2	3	3	3	3	2	3	3	1	1	2	1	3
CO3	3	2	1	3	2	2	3	2	2	2	1	2
CO4	2	3	1	2	3	3	3	1	1	2	1	3
CO5	3	3	3	3	2	3	2	1	1	3	1	2
Avg.	2.6	2.8	2.2	2.6	2.2	2.8	2.6	1.2	1.2	2.4	1	2.6

Course Description	**Lecture(s)**
Unit-I	
Introduction	**10**
FMS definition and classification of manufacturing systems, automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.	
FMS Equipment	**14**
Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment	
Unit-II	
Group Technology	**08**
GT concepts, Advantages of GT, Part family formation-coding and classification systems; Partmachine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.	
FMS related problem and Solution Methodology	**14**
FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks. FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns	

Total=48

Text Books:

1. Groover Englewood, Automation, Production System & Computer Integrated Manufacturing
2. Rankey, Design and Operation of SMS, IFS
3. Wernecks, Flexible Manufacturing System, Spring Verlag.
4. Bonctto Northox, FMS in Practice, Ford
5. W.W. Luggen, Flexible Manufacturing Cells and systems, Prentice Hall India.
6. Vishwanathan & Narahari, Performance Modelling of Automated Manufacturing Systems, Prentice Hall India