M.Tech. (Welding and Fabrication)

Semester I

S.No	Sub. Code	Subject Name	L	T	P	Hrs	CREDITS
1.	PCME-815	Conventional Welding Processes	3	0	0	3	3
2.	PCME-816	Inspection and Testing of Welds	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-817	Conventional Welding Processes Lab	0	0	2	2	1
8.	PCME-818	Inspection and Testing of Welds 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-826	Advanced Welding Processes	3	1	0	4	4
2.	PCME-827	Welding Metallurgy	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-828	Advanced Welding Processes Lab	0	0	2	2	1
7.	PCME-829	Welding Metallurgy 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

Semester	Core Elective	Course
Semester-I	Core Elective-1	PEME-811(A) Industrial Engineering
		PEME-811(B) Robotics
		PEME-811(C) Machine Tool Design
		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
		PEME-821 (D) Modeling and Simulation
	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	Core Elective Lab	Course
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.
		PEME-823 (D) Modeling and Simulation 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)

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PCME 815
Title of the course : CONVENTIONAL WELDING 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: Learn about fundamental knowledge of various conventional welding processes.
CO2: Recommend a suitable welding process along with process parameters for a particular application.
CO3: Compare different welding processes in terms of quality, productivity and economics.
CO4: Apply the knowledge of welding for solving engineering problems.
CO5: Apply the ethical principles regarding health, safety and environmental issues during welding operations.

Pre-requisite knowledge:

	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	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	2	2	1	1	2	2	3	3	3	1
CO2	3	3	3	3	3	2	2	3	1	1	3	3	3	3	2
CO3	3	3	3	3	3	2	3	2	2	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	1	2	3	3	3	3	2
CO5	3	1	1	2	2	3	3	3	1	1	2	3	2	2	3
Avg	3	2.4	2.4	2.6	2.8	2.4	2.4	2.4	1.2	1.4	2.6	3	2.8	2.8	2.2

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	04
Welding– Definition, industrial importance, applications; advantages of welding over other fabrication processes; classification of welding and allied processes.	
Welding Safety and Hazards	04
Hazards associated with gas and arc welding processes, protection against electric shock, arc radiations, fumes and dust, compressed gases, fire and explosions.	
Oxy Acetylene Welding (OAW)	04
Basic principle and equipment used; types of flames, their characteristics and applications; introduction to gas cutting.	

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Fundamentals of Arc Welding & Power Sources	04
Arc- arc characteristics- arc physics, arc plasma, arc structure, arc stability, arc efficiency; brief introduction to bead geometry and melting rate, mode of metal transfer- short circuit, globular and spray mode of transfer, various factors and forces affecting metal transfer; welding power sources- introduction to transformers, rectifiers and inverters; power source characteristics- static and dynamic volt-ampere characteristics, duty cycle; arc blow- causes and its control.	
Shielded Metal Arc Welding (SMAW)	04
Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; covered electrodes- functions of electrode coating, types of coating and their characteristics, classification and coding of covered electrodes as per IS & AWS standards; advantages, limitations and applications.	
Unit-II	
Gas Metal Arc Welding (GMAW)	04
Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; shielding gases- types, characteristics and applications; pulsed MIG welding; introduction to flux cored arc welding; advantages, limitations and applications.	
Gas Tungsten Arc Welding (GTAW)	06
Basic principle and equipment used; arc initiation method and arc stability; types of tungsten electrode and their applications; Purging techniques, shielding gases and their applications; effect of polarity on weld characteristics, requirement for DC suppresser unit; pulse TIG welding; electrode contamination; advantages, limitations and applications.	
Submerged Arc Welding (SAW)	06
Basic principle and equipment used; welding parameters and their effect on weld bead characteristics; SAW fluxes- classification and their characteristics; coding of flux wire combination as per BIS and AWS; introduction to multi-wire and multi power systems, strip cladding, narrow gap welding; advantages, limitations and applications	
Plasma Arc Welding (PAW)	04
Basic principle and equipment used; plasma forming and shielding gases; transferred and non-transferred arc modes; micro-plasma welding; advantages, limitations and applications.	
Resistance Welding	04
Basic principle; Brief introduction to spot, seam, projection and flash butt welding; welding variables; heat shrinkage, heat balance; process capabilities and applications. Stud welding, Basic principle & applications.	

Total = 48

Text Books:
1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
3. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
4. Metals Hand book, Volume 6, American Society of Metals.
5. Dave Smith, "Welding skills and technology", McGraw Hill.
6. R.Little, "Welding Technology, TMH.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code   :   **PCME 818**
Title of the course :   **INSPECTION AND TESTING OF WELDS**

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 quality control in welded joints.
CO2: Learn, identify, interpret and apply knowledge about various weld defects along with remedial measures to overcome these defects.
CO3: Learn to plan, prepare, conduct and analyze about service weldability tests including different destructive tests (mechanical tests) performed on welded joints
CO4: Learn to plan, prepare, conduct and analyze the results obtained from various non-destructive tests performed on welds.
CO5: Appraise, evaluate, report, predict and recommend/conclude on the overall strength characteristics of welds.

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

Theory

Course Description	Lecture(s)
Unit-I	
Introduction	08
Quality-Weld quality, quality assurance concept in welding; brief introduction to procedure and welder's qualification, requirement of destructive and non-destructive testing for quality control of welds.	
Welding Defects	08
Classification of weld defects, arc welding defects: surface defects like cracks, incorrect weld profile, distortion, undercuts, overlaps, dimensional defects, underfill, burn through, spatter, as well as sub-surface defects; sub-surface defects like lack of fusion, cracks, lack of penetration, blowholes, porosity, inclusions etc.	

Destructive Testing (Dt) in Welding	08
Service weldability tests: **Tension tests**: All weld metal test, longitudinal butt weld test, transverse butt weld test **Bend tests**: Free bend test, guided bend test, controlled bend test **Impact testing**: Charpy and Izod tests **Hardness tests**: Brinell, Vickers, Rockwell hardness tests, micro-hardness test **Fatigue test**- Fatigue failure, test procedure, recording of fatigue data, S-N diagram, Goodman diagram.	
UNIT-II	
NON-DESTRUCTIVE TESTING (NDT) IN WELDING	
Visual inspection of welds	02
Liquid penetrant testing	04
Dye penetrant testing – procedure, penetrant testing materials, penetrant testing method, sensitivity; applications and limitations	
Magnetic Particle Testing (MPT)	04
Definition and principle, longitudinal vs. circular magnetization, different magnetizing techniques, procedure, equipment sensitivity and limitation.	
Eddy current	04
Principle, instrument techniques, sensitivity, application and limitations;	
Radiography Testing (RT)	05
Production and properties of X-████ray sources; Basic principle and procedure; radiographic imaging- sensitivity, film speed, exposure time, film density, image quality indicators; inspection techniques- single and double wall imaging techniques; applications and limitations; real time radiography; safety against radiation hazards	
Ultrasonic testing	05
Principle of UT, basic properties of sound beam, ultrasonic transducers, inspection methods, technique for normal beam inspection, weld testing using angular probes, modes of display, immersion testing, advantage, limitations **Acoustic emission testing**: principles of AET	

Total=48

Text Books:
1. Metals Hand book (Mechanical Testing), Volume VIII, American Society of Metals.
2. S.V.Nadkarni, Modern Arc Welding Technology, Oxford & IBH.
3. Leonard P Connor, AWS Welding Hand book, Volume I, American Welding Society.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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 Co st 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

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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	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
Lagrange-Euler Formulation, Newton-Euler Formulation	
Control of manipulators	12
Position control, Force control: Applications of standard control strategies.	

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

Pre-requisite knowledge:

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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

Pre-requisite knowledge:

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	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: Gain knowledge about Iron Carbon equilibrium, TTT and CCT diagrams.
CO3: Learn and understand the use of various heat treatment processes.
CO4: Gain knowledge about various types of corrosion along with different remedial measures for its control.
CO5: Have an overview of various materials for engineering applications.

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PEME-812 (C)
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.

Pre-requisite knowledge:

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

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject code : PCME 817
Subject Title : CONVENTIONAL WELDING PROCESSES LAB

L	T	P	Credit	Weekly load
0	0	2	1	2

COURSE OUTCOMES:

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

CO1: Apply the ethical principles regarding health, safety, environmental issues during operation of welding equipment's/machines

CO2: Able to understand working principle of various welding equipment's/machines

CO3: Select and adjust welding parameters for particular applications

CO4: Handle and operate various welding equipment's/machines

COs/POs Mapping												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	3	3	3	2	2	2	3
CO2	3	3	3	3	3	2	2	2	2	1	1	3
CO3	3	3	3	3	3	2	2	1	3	2	3	3
CO4	3	3	3	2	3	2	1	3	2	2	2	3
Avg	3	3	2.75	2.25	3	2.25	2	2.25	2.25	1.75	2	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study the fumes generated during welding and protection from them.
2.	To establish and identify various flames using oxy acetylene gas welding process.
3.	To perform gas welding in flat position using oxy acetylene gas welding process.
4.	To find out the metal recovery of a covered electrode used in shielded metal arc welding process.
5.	To investigate the effect of gas flow rate on bead appearance in gas metal arc welding process
6.	To investigate the effect of polarity on bead geometry using gas tungsten arc welding process
7.	To study the effect of welding parameters on metal deposition rate using submerged arc welding process
8.	To study the effect of welding parameters on flux consumption in submerged arc welding
9.	To perform nugget test/peel test on the test specimens produce by resistance spot welding

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : **PCME 816**
Title of the course : **INSPECTION AND TESTING OF WELDS 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 various weld defects and understand the cause of occurrence of these defects along with their remedial measures to avoid these defects.
CO2: Understand the meaning of welding inspection, responsibilities of welding inspectors and certification of welding inspectors.
CO3: Develop a WPS for specific applications
CO4: Learn about various destructive and non-destructive techniques used in welding.
CO5: Apply Statistical Quality Control Techniques for testing of welds.

Pre-requisite knowledge:

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	1	3	1	2	2	2	3
CO2	3	3	2	3	2	1	2	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	2	3	2	3
CO4	3	3	3	3	3	2	3	2	3	3	2	3
CO5	3	3	3	3	3	2	3	2	3	3	2	3
Avg	3	3	2.6	3	2.8	1.8	2.8	2	2.4	2.8	2.2	3

LIST OF EXPERIMENTS :

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study about different weld defects in a butt welded joint.
2.	To fabricate a butt welded joint and extract different specimens for the mechanical evaluation of this joint.
3.	To carry out tensile testing on a butt welded joint.
4.	To carry out impact toughness studies on a butt welded joint.
5.	To carry out hardness evaluations on a butt weld.
6.	To carry out different bend tests on a butt weld joint.
7.	To carry out Liquid penetrant testing on a weld.
8.	To study Magnetic particle inspection of a weld.
9.	To study ultrasonic testing of a weld.
10.	To familiarize with Radiographic testing of a weld.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):

COs	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
CO5	3	3	3	3	3	3	3	1	2	2	3	3
Avg	3	3	3	3	2.6	2.6	1.8	1.2	2.6	2.6	2.4	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.

Pre-requisite knowledge:

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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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

Pre-requisite knowledge:

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	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: Understand the principles of heat treatment and various heat treatment processes.

CO3: Know the basic mechanisms of Phase transformations observed during the heat treatments.

CO4: To understand the various factors affecting the mechanical properties of metals and alloys.

CO5: Have an overview of various materials for engineering applications.

Pre-requisite knowledge:

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	3	2	2	3	3	2	2	2	3	1	3	1
Avg	2.2	2.8	2.2	2	2.2	2	2.2	2.2	2.8	1.8	2.2	1.4

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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PCME 826

Title of the course : ADVANCED WELDING PROCESSES

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 : Learn about fundamental knowledge of various advanced welding processes.

CO2: Recommend a suitable welding process along with process parameters for a particular application.

CO3: Compare different welding processes in terms of quality, productivity and economics.

CO4: Apply the knowledge of welding processes for solving materials joining problems.

CO5: Apply the ethical principles regarding health, safety and environmental issues during welding operations.

Pre-requisite knowledge:

	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	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	3	2	2	1	1	2	2	3	3	3	1
CO2	3	3	3	3	3	2	2	3	1	1	3	3	3	3	2
CO3	3	3	3	3	3	2	3	2	2	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	1	2	3	3	3	3	2
CO5	3	1	1	2	2	3	3	3	1	1	2	3	2	2	3
Avg	3	2.4	2.4	2.6	2.8	2.4	2.4	2.4	1.2	1.4	2.6	3	2.8	2.8	2.2

Theory

Course Description	Lecture
Unit-I	
Solid State Welding Processes	06
Friction, inertia and friction stir welding, ultrasonic welding, adhesive bonding, diffusion bonding, explosion welding- basic principle, process variables, weld characteristics, advantages, limitations and applications	
High Energy Beam Welding Processes	08
Electron Beam Welding (EBW) - basic principle, equipment details, process characteristics, process variables, advantages, limitations and applications. Laser Beam Welding (LBW) – principle of operation, different laser mediums, advantages, limitations and applications.	

Electro Slag and Electro Gas Welding	06
Principle of operation, equipment details, process variations, advantages, limitations and applications.	
Thermit Welding	04
Basic principle, thermit mixtures, pressure thermit welding, applications.	
Unit-II	
Thermal Cutting	06
Oxy-Acetylene cutting-basic principle, metal powder cutting, chemical flux cutting, oxygen lancing; Arc cutting- brief introduction to oxygen arc cutting, plasma arc cutting, metal arc cutting and gouging; advantages, limitations and applications of various techniques.	
Brazing and Soldering	06
Introduction to brazing, braze welding and soldering, various techniques, their advantages, limitations and applications; brazing & soldering consumables.	
Underwater Welding	06
Introduction, problems encountered in under water welding, types of underwater welding, Processes that can be applied for under water welding, applications of underwater welding. introduction to under water cutting process.	
Welding in space	06
Introduction, need of space welding, problems encountered in space welding, zero gravity, processes that can be applied for space welding.	

Total=48

Text Books:

1. S.V.Nadkarni, "Modern Arc Welding Technology", Oxford & IBH.
2. H.B.Cary, "Modern Arc Welding Technology", Englewood Cliffs, Prentice Hall.
3. Leonard P Connor, Welding Hand book, Volume I-III, AWS.
4. Metals Hand book , Volume 6, American Society of Metals.
5. Dave Smith, "Welding skills and technology", McGr

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PCME-827
Title of the course : WELDING METALLURGY

L	T	P	Credits
3	0	0	3

COURSE OUTCOMES:

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

CO1: Understand and identify different zones of a weldment.
CO2: Learn and understand the concept of heat flow in welding besides making calculations regarding heat flow in welding.
CO3: Understand about different Gas-metal and Slag-metal reactions in welding.
CO4: Understand about various solidification concepts related to welding and apply this knowledge for interpretation of weld microstructures.
CO5: Learn and understand various weldability tests
CO6: Understand the concept of residual stresses and distortion in welding along with applying this knowledge for actually measurement of distortion on experimental welds.

Pre-requisite knowledge:

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	2	2	2	2	2	2	2	2	3
CO2	3	3	3	3		2	2	2	2	2	2	3
CO3	3	3	3	2	2	2	2	2	2	2	2	3
CO4	3	3	3	3	3	2	2	2	2	2	2	3
CO5	3	3	2	3	3	3	2	2	2	2	3	3
CO6	3	3	3	3	3	2	2	2	2	2	1	3
Avg	3.0	3.0	2.7	2.7	2.2	2.2	2.0	2.0	2.0	2.0	2.0	3.0

Theory

Course Description	Lecture
Unit-I	
Heat flow in welding	06
Different zones of a weldment, heat flow - temperature distribution and weld thermal cycles, cooling rate - influence of heat input, joint geometry, plate thickness and preheat, Heat source, analysis of heat flow in welding, effects of welding parameters	
Chemical reactions in welding	04
Gas-metal and Slag-metal reactions in welding	
Fluid flow and metal evaporation in welding: Fluid flow in arcs and weld pools, metal evaporation	08
Weld Metal Solidification	
Epitaxial and non-epitaxial growth at fusion boundary, competitive growth in fusion zone, grain structure control, role of welding parameters on grain structure, nucleation mechanisms in weld metal. Solidification modes, dendrite and cell spacing, grain structure refinement	

Unit-II	
Weldability & weldability tests	**06**
Weldability: definition, factors affecting weldability, Fabrication weldability tests: Hot cracking and cold cracking tests	
Residual Stresses and Distortion	**12**
Residual stresses: Introduction, causes, methods of reducing residual stresses in welds Distortion: Introduction, causes, methods of controlling distortion in welds	
Weldability of specific materials	**12**
Weldability of carbon steels, stainless steels, high alloy steels, cast irons, nickel alloys, copper alloys, aluminium alloys, magnesium alloys, titanium alloys	

Total=48

Text Books:

1. Linnert G. E.,Welding Metallurgy Volume I and II, 4th Edition, AWS.
2. Granjon H., „Fundamentals of Welding Metallurgy, Jaico Publishing House.
3. Kenneth Easterling, „Introduction to Physical Metallurgy of Welding, 2nd Edition, Butterworth Heinmann.
4. Saferian D., The Metallurgy of Welding, Chapman and Hall.
5. Metals Hand book, Volume VI, American Society of Metals.
6. J.F.Lancaster, Metallurgy of Welding, Wood head.
7. Kou S., Welding Metallurgy, John Wiley.
8. R. S. Parmar, Welding Engineering & Technology, Khanna Publishers.

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.

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

Pre-requisite knowledge:

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.	

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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
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 (1 988).
6. Rooney, J. and Steadman, P., Computer Aided Design, Pitman/Open University (1987).
7. Mallineuse, G., Computational Concepts and Methods, Kogan Page Ltd. (1986)

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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 $\leq$, $=$ and $\geq$ 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.

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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 modern machining processes and their classification.
CO2: Identify different parameters required for selection of their selection.
CO3: Understand different abrasive jet machining processes.
CO4: Understand different electro-chemical processes and selection of equipment.
CO5: Know various thermal metal removal processes and their classification.

Pre-requisite knowledge:

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 modern machining processes. Considerations in process selection, Working principle, selection of processes, Material removal rate, 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 Flow Machining Process (AFM), Abrasive water jet Machining (AWJM)	

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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, Narsoa.
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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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	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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

	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	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, hard facing, 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 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.	8
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

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PCME 828
Subject title : ADVANCED WELDING PROCESS LAB

L	T	P	Credits	Weekly load
0	0	2	1	2

COURSE OUTCOMES:

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

CO1: Apply the ethical principles regarding health, safety, environmental issues during operation of welding equipments/machines

CO2: Able to understand working principle of various welding equipments/machines

CO3: Select and adjust welding parameters for particular applications

CO4: Handle and operate various welding equipments/machines

COs/POs Mapping												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	3	3	3	2	2	2	3
CO2	3	3	3	3	3	2	2	2	2	1	1	3
CO3	3	3	3	3	3	2	2	1	3	2	3	3
CO4	3	3	3	2	3	2	1	3	2	2	2	3
Avg	3	3	2.75	2.25	3	2.25	2	2.25	2.25	1.75	2	3

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To learn safety and precautions to be taken during operations of various welding equipments/machines.
2.	To perform soldering operation for joining thin sheets/wires using soldering iron
3.	To join mild steel/aluminium rods using friction welding machine
4.	To perform thermit welding process
5.	To determine power consumed in cutting a given plate with shield metal arc welding electrodes
6.	Brazing a tungsten carbide tip on a single point cutting tool shank required for turning on a lathe machine
7.	Fabrication of a small box from thin sheets using soldering process
8.	To study the effect of welding current on appearance of bead deposited using under water welding process

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code : PCME-829
Title of the course : WELDING METALLURGY LAB

L	T	P	Credits	Weekly load
0	0	4	2	4

COURSE OUTCOMES:
After successful completion of course, the students should be able to
CO1: Understand and identify different zones of a weldment.
CO2: Learn and understand the concept of heat flow in welding besides making calculations regarding heat flow in welding.
CO3: Understand about different Gas-metal and Slag-metal reactions in welding.
CO4: Understand about various solidification concepts related to welding and apply this knowledge for interpretation of weld microstructures.
CO5: Learn and understand various weldability tests
CO6: Understand the concept of residual stresses and distortion in welding along with applying this knowledge for actually measurement of distortion on experimental welds.

Pre-requisite knowledge:

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	2	3	2	3	2	2	2	2	3
CO2	3	3	3	3	3	2	2	2	2	2	2	3
CO3	3	3	3	2	3	2	2	2	2	2	2	3
CO4	3	3	3	3	3	2	3	2	2	2	2	3
CO5	3	3	2	3	3	3	2	2	2	2	3	3
CO6	3	3	3	3	3	2	2	2	2	2	2	3
Avg	3.0	3.0	2.7	2.7	3.0	2.2	2.3	2.0	2.0	2.0	2.2	3.0

LIST OF EXPERIMENTS:

S.NO.	DESCRIPTION OF EXPERIMENT
1.	To study and analyze the optical microstructure of different welds.
2.	To evaluate the microhardness of different zones of a weldment.
3.	To study influence of welding parameters on weld bead formation.
4.	To study and measure angular distortion in a butt welded joint.
5.	To study the application of Rosenthal's equation to actual welds.
6.	To study different prediction diagrams applicable for ferrite content in different stainless steel welds.
7.	To determine and analyze ferrite content in austenitic stainless steel welded joints.
8.	To study weldability issues related to cast iron weldments.
9.	To study the influence of post weld thermal aging on corrosion properties of austenitic stainless steel welds.
10.	To study desensitization procedures for austenitic stainless steel welds.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

Pre-requisite knowledge:

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.

Pre-requisite knowledge:

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.

Pre-requisite knowledge:

COs	CO/PO Mapping: (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):											
	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 and functions.

Pre-requisite knowledge:

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.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

Subject Code   :   **PEME-911 (C)**
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.

Pre-requisite knowledge:

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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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 knowledge:

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	PSO 1	PSO 2	PSO 3
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 Technolog y, Dhanpat Rai

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

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

Pre-requisite knowledge:

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	

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

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.

Pre-requisite knowledge:

COs	CO/PO Mapping : (Strong(S) / Medium(M) / Weak(W) indicates strength of correlation):											
	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.

Pre-requisite knowledge:

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	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 an alysis 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

Pre-requisite knowledge:

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	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 Nois e 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.

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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	

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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 Appli cations	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, 20 06.
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 Fra ncis.

SLIET LONGOWAL

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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

Pre-requisite knowledge:

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 Ai ded 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.

Pre-requisite knowledge:

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.

Pre-requisite knowledge:

	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

1.2.7 - WELDING AND FABRICATION (PG-WLF)

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.

Pre-requisite knowledge:

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.

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1.2.7 - WELDING AND FABRICATION (PG-WLF)

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 operational problems in these manufacturing systems.
CO4: Understand the concept of group technology.
CO5: Learn, calculate the solution methodology of FMS related manufacturing issues

Pre-requisite knowledge:

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