OPERATIONS RESEARCH

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Operations Research	15ME81	4	3-2-0	80	20	3 Hrs

Course objectives:

1. To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.
2. To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and machinery.

MODULE -1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR,
Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).
08 Hours

MODULE -2

LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

12 Hours

MODULE -3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem.

Assignment Problem- Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems.
12 Hours

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MODULE -4

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems.

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

10 Hours

MODULE -5
Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.
Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.   08 Hours

Course outcomes:
  On completion of this subject, students will be able to:

1. Understand the meaning, definitions, scope, need, phases and techniques of operations research.
2. Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
3. Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
4. Solve problems on game theory for pure and mixed strategy under competitive environment.
5. Solve waiting line problems for M/M/1 and M/M/K queuing models.
6. Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks.
7. Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm.

TEXT BOOKS:
  1. Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD.

Publications, New Delhi – 2007
  2. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private
        Limited, 2006.

REFERENCE BOOKS:
1. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press,
Laxmi Publications Pvt. Ltd. 2016.
 2. Operations Research, Paneerselvan, PHI

3. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
4. Introduction to Operations Research, Hillier and Lieberman, 8th Ed., McGraw Hill

Scheme of Examination:
Two questions   to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

ADDITIVE MANUFACTURING

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Additive Manufacturing	15ME82	4	4-0-0	80	20	3 Hrs

Course Objectives:

Students will be able to

1. Understand the additive manufacturing process, polymerization and powder metallurgy process

2. Understand characterisation techniques in additive manufacturing.

3. Acquire knowledge on CNC and Automation.

Module 1	
Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM, **AM process chain:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing. **Classification of AM processes:** Liquid polymer system, Discrete particle system, Molten material systems and Solid sheet system. **Post processing of AM parts:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques. **Guidelines for process selection**: Introduction, selection methods for a part, challenges of selection **AM Applications:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries	**10 Hours**

Module 2	
System Drives and devices: Hydraulic and pneumatic motors and their features, Electrical motors AC/DC and their features **Actuators:** Electrical Actuators; Solenoids, Relays, Diodes, Thyristors, Triacs, Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.	**8 Hours**

Module 3	
POLYMERS & POWDER METALLURGY **Basic Concepts:** Introduction to Polymers used for additive manufacturing: polyamide, PF resin, polyesters etc. Classification of polymers, Concept of functionality, Polydispersity and Molecular weight [MW], Molecular Weight Distribution [MWD] **Polymer Processing:** Methods of spinning for additive manufacturing: Wet spinning, Dry spinning. Biopolymers, Compatibility issues with polymers. Moulding and casting of polymers, Polymer processing techniques **General Concepts:** Introduction and History of Powder Metallurgy (PM), Present and Future Trends of PM **Powder Production Techniques:** Different Mechanical and Chemical methods, Atomisation of Powder, other emerging processes. **Characterization Techniques**: Particle Size & Shape Distribution, Electron Microscopy of Powder, Interparticle	**12 Hours**

	Friction, Compression ability, Powder Structure, Chemical Characterization **Microstructure Control in Powder:** Importance of Microstructure Study, Microstructures of Powder by Different techniques **Powder Shaping:** Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process Variables, Pressure & Density Distribution during Compaction, Isotactic Pressing, Injection Moulding, Powder Extrusion, Slip Casting, Tape Casting. **Sintering:** Theory of Sintering, Sintering of Single & Mixed Phase Powder, Liquid Phase Sintering Modern Sintering Techniques, Physical & Mechanical Properties Evaluation, Structure-Property Correlation Study, Modern Sintering techniques, Defects Analysis of Sintered Components **Application of Powder Metallurgy:** Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, Biomaterials etc.	
Module 4		
	NANO MATERIALS & CHARACTERIZATION TECHNIQUES: **Introduction:** Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology **Nano-materials Synthesis and Processing:** Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of Nano-materials- sol-gel process; Gas Phase synthesis of Nano-materials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation(CVC). **Optical Microscopy -** principles, Imaging Modes, Applications, Limitations. **Scanning Electron Microscopy (SEM) -** principles, Imaging Modes, Applications, Limitations. **Transmission Electron Microscopy (TEM) -** principles, Imaging Modes, Applications, Limitations. **X- Ray Diffraction (XRD) -** principles, Imaging Modes, Applications, Limitations. **Scanning Probe Microscopy (SPM) -** principles, Imaging Modes, Applications, Limitations. **Atomic Force Microscopy (AFM)** - basic principles, instrumentation, operational modes, Applications, Limitations. **Electron Probe Micro Analyzer (EPMA) -** Introduction, Sample preparation, Working procedure, Applications, Limitations.	**10 Hours**
Module 5		
	MANUFACTURING CONTROL AND AUTOMATION **CNC technology - An overview:** Introduction to NC/CNC/DNC machine tools, Classification of NC /CNC machine tools, Advantage, disadvantages of NC /CNC machine tools, Application of NC/CNC **Part programming:** CNC programming and introduction, Manual part programming: Basic (Drilling, milling, turning etc.), Special part programming, Advanced part programming, Computer aided part programming (APT) **Introduction:** Automation in production system principles and strategies of automation, basic Elements of an automated system. Advanced Automation functions. Levels of Automations, introduction to automation productivity **Control Technologies in Automation:** Industrial control system. Process industry vs discrete manufacturing industries. Continuous vs discrete control. Continuous process and its forms. Other control system components.	**10 Hours**

Course Outcomes

1. Understand the different process of Additive Manufacturing. using Polymer, Powder and Nano materials manufacturing.
2. Analyse the different characterization techniques.
3. Describe the various NC, CNC machine programing and Automation techniques.

TEXT BOOKS:
1. Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World Scientific, 2003.
2. G Odian Principles of Polymerization, Wiley Inerscience John Wiley and Sons, 4th edition, 2005
3. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.

4. Powder Metallurgy Technology, Cambridge International Science Publishing, 2002.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.
6. Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

REFERENCE BOOKS:
1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000
2. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Cryogenics	15ME831	03	3-0-0	80	20	3 Hrs

CRYOGENICS

Course objectives:

1. To understand cryogenic system and gas liquefaction system

2. To analyze gas cycle cryogenic refrigeration system

3. To Comprehend gas separation and gas purification system

4. To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids

5. To study applications of cryogenics and to embark on cryogenic fluid

Module 1

Introduction to Cryogenic Systems:

Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion.

Gas Liquefaction Systems:

Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.

10hrs

Module 2

Gas Cycle Cryogenic Refrigeration Systems:

Classification of Cryo coolers Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirling cryo-cooler, Free displacer split type Stirling Cryo coolers, Gifford Mcmahon Cryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators. 10hrs

Module 3

Gas Separation and Gas Purification Systems

Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation,

Linde single column air separation. Linde double column air separation, Argon and Neon separation systems.

Ultra Low Temperature Cryo – Refrigerators

Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors.
10hrs

Module 4

Vacuum Technology

Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation.
10hrs

Module 5

Cryogenic Fluid Storage And Transfer Systems

Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self pressurization, Transfer pump.

Application of Cryogenic Systems

Cryogenic application for food preservation – Instant Quick Freezing techniques Super conductive devices, Cryogenic applications for space technology.
Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.
10hrs

Course outcomes:

   On completion of this subject students will be able to:
1. To be able to understand the cryogenic system.
2. To have complete knowledge of cryogenic refrigeration system
3. To be able to design gas separation and gas purification system
4. To able to solve the problem in , insulation, storage of cryogenic liquids
5. To be able to apply cryogenic in various areas and to be able take up research in cryogenics

TEXT BOOKS

1. Cryogenic Systems – R.F. Barron

2. Cryogenic Engineering – R.B. Scott – D.Van Nostrand Company, 1959

REFERENCE BOOKS

1. Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989

2. High Vacuum Technology – A. Guthree – New Age International Publication

3. Experimental Techniques in Low Temperature Physics – G.K. White – Osford University Press,

E- Learning

- VTU, E- learning
- NPTEL

Scheme of Examination:
Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

EXPERIMENTAL STRESS ANALYSIS

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Experimental Stress Analysis	15ME832	3	3-0-0	80	20	3 Hrs

Course Learning Objectives (CLO's):
1. To use the method of electrical strain gauges to study and characterize the elastic behavior of solid bodies.
2. To measure displacement and perform stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. To describe the photo elastic method to study and characterize the elastic behavior of solid bodies.
4. To determine stress strain behavior of solid bodies using methods of coating.
5. To conduct stress strain analysis of solid bodies using the methods Holography

Module - 1

Introduction: Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. general consideration in data analysis.

03Hours

Electrical Resistance Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance' Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

05 Hours

Module -2

Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

04 Hours

Force, Torque and strain measurements: Mass balance measurement, Elastic element for force measurements, torque measurement.

02 Hours

Module – 3

Photoelasticity: Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circuclar polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques , Calibration photoelastic model materials

06Hours

Two Dimensional Photoelasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photoelastic model materials, Materials for 2D photoelasticity

<div align="right">**02 Hours**</div>

Module - 4

Three Dimensional Photo elasticity: Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses.

<div align="right">**04 Hours**</div>

Photoelastic (Birefringent) Coatings : Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings

<div align="right">**06 Hours**</div>

Module – 5

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

<div align="right">**05Hours**</div>

Moire Methods: Moire fringes produced by mechanical interference .Geometrical approach, Displacement field approach to Moire fringe analysis, 0ut of plane displacement measurements, Out of plane slope measurements .Applications and advantages

<div align="right">**05Hours**</div>

Course Outcomes (CO's):
At the end of the course, the student will be able to:
1. Explain characterize the elastic behavior of solid bodies.
2. Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. Discuss skills for experimental investigations an accompanying laboratory course is desirable
4. Discuss experimental investigations by predictions by other methods.
5. Describe various coating techniques.

TEXT BOOKS:
1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.
3. **Experimental stress Analysis**, Srinath L.S tata Mc Graw Hill.

REFERENCES BOOKS :

1. **"Photoelasticity Vol I and Vol II,** M.M.Frocht, John Wiley & sons.
2. **"Strain Gauge Primer",** Perry and Lissner,
3. **"Photo Elastic Stress Analysis",** Kuske, Albrecht & Robertson John Wiley & Sons.
4. **"Motion Measurement and Stress Analysis",** Dave and Adams,
5. **Holman, Experimental Methods for Engineers,** Tata McGraw-Hill Companies, 7th Edition, New York, 2007.
6. **B. C. Nakra and K. K. Chaudhry**, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Companies, Inc, New York, 7th Edition, 2006.

 Scheme of Examination: Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.

THEORY OF PLASTICITY

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Theory of Plasticity	15ME833	3	3-0-0	80	20	3 Hrs

Pre-requisite: This course requires sufficient solid mechanics and theory of elasticity background and basic knowledge about materials and their mechanical properties.

Course objectives:

CLO1	To introduce the concepts of Plasticity and mechanism of plastic deformation in metals.
CLO2	To expose the students to elasto-plastic problems involving plastic deformation of beams and bars.
CLO3	To introduce the concepts of slip line field theory.

Module 1
Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation; concept of strain, engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, cubical dilation, generalized Hooke's law, numerical problems.

8 Hours

Module 2
Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or Luder's cubes.

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two dimensional stress space), experimental evidence for yield criteria, problems.

9 Hours

Module 3
Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-Von Mises equation, Prandtl- Reuss and Saint Venant theory, experimental verification of Saint Venant's theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance.

8 Hours

Module 4

Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems.

Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems.

9 Hours

Module 5

Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets.

8 Hours

Course outcomes:

At the end of course, student will able to:

CLO1	Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.
CLO2	Understand plastic stress-strain relations and associated flow rules.
CLO3	Perform stress analysis in beams and bars including Material nonlinearity.
CLO4	Analyze the yielding of a material according to different yield theory for a given state of stress.
CLO5	Interpret the importance of plastic deformation of metals in engineering problems.

Scheme of Examination:

Two questions to be set from each module. Students have to answer five full questions, choosing one full question from each module.

Text Books:

1. "Theory of Plasticity", Chakraborty, 3rd Edition Elsevier.
2. "Theory of Plasticity and Metal forming Process" - Sadhu Singh, Khanna Publishers, Delhi.

References Books:

1. "Engineering Plasticity - Theory and Application to Metal Forming Process" -R.A.C. Slater, McMillan
   Press Ltd.
2. "Basic Engineering Plasticity", DWA Rees, 1st Edition, Elsevier.
3. "Engineering Plasticity", W. Johnson and P. B. Mellor, Van NoStrand Co. Ltd 2000
4. Advanced Mechanics of solids, L. S. Srinath, Tata Mc. Graw Hill, 2009.

Green Manufacturing

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Green Manufacturing	15ME834	3	3-0-0	80	20	3 Hrs

COURSE OBJECTIVES
Students will be able to
1. Acquire a broad understanding of sustainable manufacturing, green product and process
2. Understand the analytical tools, techniques in green manufacturing
3. Understand the structures of sustainable manufacturing, environmental and management practice.

Module- 1
Introduction to Green Manufacturing
Why Green Manufacturing, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing.
The Social, Business, and Policy Environment for Green Manufacturing

Introduction, The Social Environment—Present Atmosphere and Challenges for Green Manufacturing, The Business Environment: Present Atmosphere and Challenges, The Policy Environment—Present Atmosphere and Challenges for Green Manufacturing.

Module- 2

Metrics for Green Manufacturing

Introduction, Overview of Currently Used Metrics, Overview of LCA Methodologies, Metrics Development Methodologies, Outlook and Research Needs.

Green Supply Chain

Motivation and Introduction, Definition, Issues in Green Supply Chains (GSC), Techniques/Methods of Green Supply Chain, Future of Green Supply Chain.

Principles of Green Manufacturing
Introduction, Background, and Technology Wedges, Principles, Mapping Five Principles to Other Methods and Solutions.

Module -3
Closed-Loop Production Systems

Life Cycle of Production Systems, Economic and Ecological Benefits of Closed Loop Systems, Machine Tools and Energy Consumption, LCA of Machine Tools, Process Parameter Optimization, Dry Machining and Minimum Quantity Lubrication, Remanufacturing, Reuse, Approaches for Sustainable Factory Design.

Semiconductor Manufacturing

Overview of Semiconductor Fabrication, Micro fabrication Processes, Facility Systems, Green Manufacturing in the Semiconductor Industry: Concepts and Challenges, Use-Phase Issues with Semiconductors, Example of Analysis of Semiconductor Manufacturing.

Module- 4

Environmental Implications of Nano-manufacturing

Introduction, Nano-manufacturing Technologies, Conventional Environmental Impact of Nano-manufacturing, Unconventional Environmental Impacts of Nano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies.

Green Manufacturing Through Clean Energy Supply

Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supply in Green Manufacturing

Module- 5

Packaging and the Supply Chain: A Look at Transportation

Introduction, Background, Recommended Method to Determine Opportunities for Improved Pallet Utilization, Discussion.

Enabling Technologies for Assuring Green Manufacturing

Motivation, Process Monitoring System, Applying Sensor Flows in Decision Making: Automated Monitoring, Case Study.

Concluding Remarks and Observations about the Future

Introduction, Evolution of Manufacturing, Leveraging Manufacturing, Energy of Labor.

COURSE OUTCOMES
1. Understand the basic design concepts, methods, tools, the key technologies and the operation of sustainable green manufacturing.
2. Apply the principles, techniques and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.
3. Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements.
4. Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management and supply chain management scheme.

PRODUCT LIFE CYCLE MANAGEMENT

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Product Life Cycle Management	15ME835	3	3-0-0	80	20	3 Hrs

Course objectives:
This course enables students to
1. Familiarize with various strategies of PLM
2. Understand the concept of product design and simulation.
3. Develop New product development ,product structure and supporting systems
4. Interpret the technology forecasting and product innovation and development in business processes.
5. Understand product building and Product Configuration.

MODULE 1:
 INTRODUCTION TO PLM AND PDM
Introduction to PLM,Need for PLM,opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.

MODULE 2:
 PRODUCT DESIGN
Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modelling and simulation in product

8Hrs.

MODULE 3:
PRODUCT DEVELOPMENT
New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.

8Hrs.

MODULE 4:
TECHNOLOGY FORECASTING
Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.

8Hrs.

MODULE 5:
PRODUCT BUILDING AND STRUCTURES
Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process)

planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.

8Hrs

Scheme of Examination:
Two question to be set from each module. Students have to answer five full questions, choosing at least one full question from each module.
Course Outcomes:

Student will be able to

1. Explain the various strategies of PLM and Product Data Management
2. Describe decomposition of product design and model simulation
3. Apply the concept of New Product Development and its structuring.
4. Analyze the technological forecasting and the tools in the innovation.
5. Apply the virtual product development and model analysis

Text Books:

1.Stark, John. *Product Lifecycle Management: Paradigm for 21st Century Product Realisation*, Springer-Verlag, 2004. ISBN 1852338105

2.Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006
Reference Books:
1.. Saaksvuori Antti / Immonen Anselmie, product Life Cycle Management Springer,Dreamtech,3-540-25731-4

2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

Internship/ Professional Practice

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Internship/ Professional Practice	15ME84	2	Industry Oriented	50	50	3 Hrs

Project Work, Phase II

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Project Work, Phase II	15MEP85	6	0-6-0	100	100	3 Hrs

Seminar

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIA	
Seminar	15MES86	1	0-4-0	100	-	-