VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION (2017)

B.E. in MECHANICAL ENGINEERING

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Hours /Week			Examination				Credits
			Lecture	Tutorial	Practical	Duration (Hours)	SEE Marks	CIE Marks	Total Marks	
1	17ME81	Operations Research	03	02	00	03	60	40	100	4
2	17ME82	Additive Manufacturing	04	00	00	03	60	40	100	4
3	17ME83X	Professional Elective - V	03	00	00	03	60	40	100	3
4	17ME84	Internship / Professional Practice	Industry Oriented			03	50	50	100	2
5	17ME85	Project Phase – II	--	06	--	03	100	100	200	6
6	17MES86	Seminar	--	04	--	--	--	100	100	1
TOTAL			**10**	**12**	**00**	15	**330**	**370**	**700**	**20**

Professional Elective-V	
15ME831	Cryogenics
15ME832	Experimental Stress Analysis
15ME833	Theory of Plasticity
15ME834	Green Manufacturing
15ME835	Product life cycle management

Core subject: This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study. **Professional Elective:** Elective relevant to chosen specialization/ branch. **Internship / Professional Practice:** To be carried out between 6th& 7th semester vacation or 7th& 8th semester vacation. As per 2017 regulation Internship CIE marks are 50(25 seminar and 25- report) and SEE 50 for viva-voce.

OPERATIONS RESEARCH
B.E, VIII Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME81**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**
Credits – 04			

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 studentsto 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. SolutionstoLPP by graphical method(Two Variables).

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.

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.

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. Crashingofnetworks- 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.

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 of2 jobs on 'm' machines using graphical method.

Course outcomes:

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 networkdiagrams 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-3machines,n jobs-m machinesand 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.
3. Introduction to Operations Research, Lieberman/Nag/Basu, 9th Edition, McGraw Hill Education Pvt.Ltd.,

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,8thEd., McGraw Hill

ADDITIVE MANUFACTURING
B.E, VIII Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME82**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**04**	**SEE Marks**	**60**
Total Number of Lecture Hours	**50(10 Hours per Module)**	**Exam Hours**	**03**

Credits – 04

Course Objectives:

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.

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, andTriacs. Hydraulic and Pneumatic actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys.

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 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.

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.

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 Interscience 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.

CRYOGENICS
B.E, VIII Semester, Mechanical Engineering
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME831**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40(8 Hours per Module)**	**Exam Hours**	**03**

Credits – 03

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 liquefactionsystems.

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 Stirlingcryo-cooler, Free displacer split type StirlingCryo coolers, Gifford McmahonCryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.

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.

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

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.

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.VanNostrand 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,

EXPERIMENTAL STRESS ANALYSIS

B.E, VIII Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME832**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40(8 Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objectives:

4. **To understand the measurement of stain using electrical strain gauges.**
5. **To analyze stress and strains induced mechanical systems using electrical strain gauges.**
6. **To understand the photo elastic techniques to characterize the elastic behavior of solids.**
7. **To understand elastic behavior of solid bodies using coating techniques.**
8. **To apply the holography methods to measure stress and strains.**

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.

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.

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

Module - 3

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

Module - 4

Three Dimensional Photo elasticity: Stress freezing method, Scattered lightphotoelasticity, Scattered light as an interior analyzer and polarizer, Scattered lightpolariscope and stress data Analyses.
Photoelastic (Birefringent) Coatings : Birefringence coating stresses, Effects ofcoating thickness: Reinforcing effects,
Poission's Stress separation techniques: Oblique incidence.

Module - 5

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

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

Course outcomes:

1. **Explain and the elastic behavior of solid bodies.**
2. **Describe stress strain analysis of mechanical systems using electrical resistance strain gauges.**
3. **Understand the experimental methods of determining stresses and strains induced.**
4. **Apply the coating techniques to determine the stresses and strains.**

TEXT BOOKS:

1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.

REFERENCE BOOKS

1. **Experimental stress Analysis**, Srinath L.S tata Mc Graw Hill.
2. **"PhotoelasticityVol I and Vol II,** M.M.Frocht, John Wiley & sons.
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

THEORY OF PLASTICITY

B.E, VIII Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME833**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40(8 Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objectives:

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

Module - 1

Briefreviewf fundamentals of elasticity:Concept of stress, stress invariants, principal Stresses, octahedralnormalandshearstresses,sphericalanddeviatoricstress,stress transformation;concept of strain,engineeringandnaturalstrains, octahedralstrain,deviator and spherical strain tensors, strainrateandstrainrate tensor, cubical dilation, generalized Hooke's law, numerical problems.

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.

Module - 3

Stress Strain Relations: Idealised stress-strain diagramsfor differentmaterialmodels, empirical equations,Levy-VonMises equation, Prandtl-Reuss andSaintVenant 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.

Module - 4

Bending of Beams:Stages ofplasticyielding, 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.

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.

Course outcomes:

- **Understand stress, strain, deformations, relation between stress and strain and plastic deformation in solids.**
- **Understand plastic stress-strain relations and associated flow rules.**
- **Perform stress analysis in beams and bars including Material nonlinearity.**
- **Analyze the yielding of a material according to different yield theory for a given state of stress.**

- **Interpret the importance of plastic deformation of metals in engineering problems**

TEXT BOOKS:

1. "Theory of Plasticity", Chakraborty, 3rd Edition Elsevier.
2. "TheoryofPlasticityand Metal formingProcess"-Sadhu Singh, KhannaPublishers, Delhi.

REFERENCE BOOKS

1. "EngineeringPlasticity-TheoryandApplicationto Metal FormingProcess" -R.A.C. Slater, McMillan PressLtd.
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

B.E, VIII Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME834	CIE Marks	40
Number of Lecture Hours/Week	03	SEE Marks	60
Total Number of Lecture Hours	40(8 Hours per Module)	Exam Hours	03

Credits – 03

Course Objectives:

- **Acquire a broad understanding of sustainable manufacturing, green product and process**
- **Understand the analytical tools, techniques in green manufacturing**
- **Understand thestructures 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.

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 Impactof Nano-manufacturing, Unconventional Environmental ImpactsofNano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies.

Green Manufacturing Through Clean Energy Supply
Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supplying Green Manufacturing

Module - 5

Packaging and the Supply Chain: A Look at Transportation
Introduction, Background, Recommended Method to Determine Opportunitiesfor 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:

- **Understand the basic design concepts, methods, tools, the key technologies and the operation of sustainable green manufacturing.**
- **Apply the principles, techniques and methods to customize the learned generic concepts to meet the needs of a particular industry/enterprise.**
- **Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements.**
- **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

B.E, VIII Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17ME835**	**CIE Marks**	**40**
Number of Lecture Hours/Week	**03**	**SEE Marks**	**60**
Total Number of Lecture Hours	**40(8 Hours per Module)**	**Exam Hours**	**03**

Credits – 03

Course Objectives:

- **Familiarize with various strategies of PLM**
- **Understand the concept of product design and simulation.**
- **Develop New product development,product structure and supporting systems**
- **Interpret the technology forecasting and product innovation and development in business processes.**
- **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

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.

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

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.

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.

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:

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

Text Books:

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

2. Fabio Giudice, Guido La Rosa, Product Design for the environment-A lifecycle approach, Taylor & Francis 2006

Reference Books:

1.. SaaksvuoriAntti / ImmonenAnselmie, 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	CIE	
Internship/ Professional Practice	17ME84	2	Industry Oriented	50	50	3 Hrs

Internship / Professional Practice: To be carried out between 6th& 7th semester vacation or 7th& 8th semester vacation. As per 2017 regulation Internship CIE marks are 50(25 seminar and 25- report) and SEE 50 for viva-voce

Project Work, Phase II

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIE	
Project Work, Phase II	17MEP85	6	0-6-0	100	100	3 Hrs

Seminar

Course	Code	Credits	L-T-P	Assessment		Exam Duration
				SEE	CIE	
Seminar	17MES86	1	0-4-0	----	100	---