Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum for

Third Year

Industrial Engineering

(2019 Course)

(with effect from June 2021)

Savitribai Phule Pune University, Pune
TE (Industrial Engineering)
2019 Course
(With effect from Academic Year 2021-22)

Semester-V

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Seminar	IN-Sem	End-Sem	TW	PR	OR	Total	TH	PR	Seminar	Total
311101(A)	Production & Operations Management	3			30	70				100	3			3
311102(A)	Machine Design	3			30	70				100	3			3
311103(A)	Work study	3			30	70				100	3			3
311104(A)	Metrology & QC	3			30	70				100	3			3
311105(A)	Elective-I	3			30	70				100	3			3
311101(B)	Metrology & QC Lab		2					50		50		1		1
311102(B)	Production Practice- IV		2				25			25		1		1
311103(B)	Computer Programming & Applications		2				25			25		1		1
311104(B)	Work Study Lab		2						25	25		1		1
311105(B)	Elective 1 Lab		2						25	25		1		1
311106	Seminar			1			50			50			1	1
311107	Mandatory Audit Course 5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**1**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**5**	**1**	**21**

Elective 1:

I. Product Design and Development
II. Nano Manufacturing
III. Statistics and Numerical Methods
IV. Financial Management and Costing

Mandatory Audit Course 5: Students should select one of the following subjects as an Audit Course

I. Disaster Management
II. Industrial Waste Management

Savitribai Phule Pune University, Pune TE (Industrial Engineering) 2019 Course (With effect from Academic Year 2021-22)														
Semester-VI														
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit**			
		Theory	**Practical**	**Internship**	**IN-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Internship**	**Total**
311108(A)	Operation Research	3			30	70				100	3			3
311109(A)	Ergonomics & Product Design	3			30	70				100	3			3
311110(A)	Facilities Planning	3			30	70				100	3			3
311111(A)	Elective-II	3			30	70				100	3			3
311108 (B)	Operation Research Lab		2					50		50		1		1
311109(B)	Ergonomics & Product Design Lab		2				25			25		1		1
311110(B)	Facilities Planning Lab		2				50			50		1		1
311111(B)	Elective-II Lab		2						50	50		1		1
311112	Fabrication Lab		2				25			25		1		1
311113	Internship			4			100			100			4	4
311114	Mandatory Audit Course 6	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**12**	**10**	**4**	**120**	**280**	**200**	**50**	**50**	**700**	**12**	**5**	**4**	**21**

Abbreviations:
TH : Theory TW : Term Work PR : Practical
OR : Oral TUT : Tutorial

Elective 2:

I. Finite Element Analysis
II. Advances in Manufacturing Processes
III. Mechatronics
IV. Materials Management

Mandatory Audit Course 6: Students should select one of the following subjects as an Audit Course

I. Technical writing and communication skill
II. Energy Auditing and Management in Industries

Production & Operations Management

311101(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Course Outcomes:
At the end of the course student will be able to

1. Describe basic concept of production and operations management
2. Design the new products keeping in view various aspects such as manufacturing, assembly, customer etc.
3. Use various tools for product design
4. Perform analysis for facility location and plant layout
5. Select and design appropriate material handling system

Unit I: Introduction **(6)**
History of Operations Management, Operations Organization. Concept of manufacturing and operations management engineering productivity, efficiency utilization, difference between products and service, interrelationship of profitability and productivity, productivity in relationship to material.

Unit II: Operations Strategy **(6)**
Competitiveness with Operations, Competing on cost, quality, flexibility, speed, Productivity, efficiency & effectiveness.

Unit III: Products & Services Design **(6)**
New product development: strategies and processes, design process, Cross functional product design, designing for manufacture and assembly, designing for customer, concurrent design and concurrent engineering, considerations in service design, Product design tools – QFD, Value analysis, Modular design, Product life cycle, Taguchi methods, Process analysis, process flow charting, types and evaluation.

Unit IV: Processes & Technology **(6)**
Types of production systems – Mass, Process, Job Shop, Batch, Project, etc. Process selection types, flow structures, process re-engineering, product process matrix and virtual factory, Technology decisions, Classification of process technologies - manual, mechanized & automated, Process technology in service and non manufacturing operations - distribution and transport, warehousing, point of sale system and banking operations.

Unit V: Facilities Layout **(6)**
Facility location analysis, basic layouts, designing process layouts, designing product layouts, designing hybrid layouts, Locating production and services facilities: importance of location factor affecting location decisions, Introduction to the concept of line balancing, cycle time, determination of workstation and efficiency, sensitivity analysis of the same.

Unit VI: Material Handling Systems: **(6)**
As a necessary evil, indicators of poor material handling, principle of good material handling system, different material handling equipment, Material handling function, MH principles, MH Equipment – Cranes & Hoists, Conveyors, Industrial Trucks, AGVs, AS-RS systems, etc.

Text book:

1. Chase, Aquilano and Jacobs, Operations Management for Competitive Advantage, TMH
2. R. Paneerselvam, Production and Operations, PHI, 2012.
3. Shailendra Kale, Production and Operations Management, Tata McGraw-Hill

Reference books:

1. Gaither Norman & Frazier, Operations Management, Southwestern Publishing
2. L.C. Jhamb, Purchase Management,Everest publication
3. S.N Chary, Production and Operation Management, Tata Mc Graw Hill
4. Adams, Evereet & Ronald J, Production and Operation Management by 5/e, PHI

Machine Design

311102(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites: Basic mechanical Engineering, Engineering Mechanics, Mechanics of Materials,

Course Outcomes: On successful completion of the course students should be able to-

1. Analyze the stress and strain on mechanical components;
2. Identify and quantify failure modes for mechanical parts such as gears, bearings and flywheels.
3. Demonstrate knowledge on basic machine elements used in design of machine elements subjected to static and fatigue loads for a given practical application.

Unit I: Spur Gears **(6)**

Introduction, Standard Proportions of Gear Systems, Gear Materials, various design considerations, Beam Strength of gear teeth- Lewis Equation, tangential loading, module Calculations, width calculations, Dynamic tooth loads, Spott's Equation, types of gear tooth failures, Spur Gear construction, Design of shaft for Spur Gears, Design of arms for Spur Gears.

Unit- II: Helical Gears: **(6)**

Introduction, Terms used in Helical Gears, Face width of Helical Gear Formative no. of teeth and minimum no. of teeth to avoid interference and undercutting, Proportion of the Helical Gears, Strength of Helical Gears, Design of Helical Gears.

Unit III: Rolling Contact Bearings **(6)**

Types, Static and Dynamic load Capacity, Stribeck's Equation, Concept of equivalent load, Load life Relationship, Selection of bearing from Manufacturer's Catalogue, Design for variable loads and Speeds, Bearings with Probability of Survival other than 90%, Lubrication and Mounting of bearings, oil Seals and packing used for bearings.

Unit IV: Design for fluctuating loads **(6)**

Stress Concentration and remedies, S. N. Diagram, Endurance limit, Factors affecting Endurance Strength, Design for Finite and Infinite life under reverse stresses, Cumulative damage, Sodberg's and Goodman's Diagram, Design of components like shaft, bolted joints, springs etc. subjected to variable loading.

Unit V: Design for Manufacture **(6)**

General Principles for Design for Manufacture, Principles of design for casting, Forging, Machining, Welded Joints, etc., Design for Manufacturing Assembly **Statistical Considerations in Design**: Analysis of Tolerances, Assembly of parts, Design and Natural Tolerances, Normal Distribution, Applications in Design Process**.**

Unit VI: Flywheel **(6)**

Introduction, Coefficient of fluctuation of speed, Fluctuation of energy, Maximum fluctuation of energy, Energy stored in flywheel, Stresses in flywheel rim, Stresses in flywheel Arms, Design of shaft, hub and key, construction of flywheel. Optimization Techniques:- The concept of optimization, Classification of optimization problem, engineering, applications of optimization, Role of computers in optimization, Mathematical formulation of optimization problems. Johnson's method for mechanical engineering design. Typical design equation, Classification, example.

Text Books

1. Bhandari V.B., Design of Machine Elements, Tata McGraw Hill Publication.
2. Shigly, Mechanical Engineering Design, , McGraw Hill Publication.

Reference Books

3. M.F.Spott, Design of Machine Elements, Prentice Hall.
4. Design Data Book, PSG College Technolgy.
5. Willium C.Ortwein, Machine Component Design, West Pub.Co. and Jaico Publication House.
6. R.K.Jain, Machine Design, Khanna Publication Delhi.
7. R.S.Khurmi & Gupta J.K., A Text book of Machine Design, S.Chand and Compan

Work Study

311103(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites: Organizational structure, Fundamental of business, Basic Mathematical Operation, Manufacturing Processes

Course Outcomes:

Students will be able to

1. Differentiate between different types of Tools and techniques of industrial engineering
2. Understand and implement the concepts of different types of Method study Techniques.
3. Understand and implement the concepts of different types of Work Measurement Techniques.
4. Understand different types of Job Evaluation Systems and application of Work Study.

Unit I: Introduction to Industrial Engineering: **(6)**

Historical background, Contribution of Taylor and Gilbreth, Productivity Improvement, Work content analysis, Definition and scope of Work Study.

Unit II: Method Study **(6)**

Definition, Steps in method Study, need to record the activities, symbols in charting, different recording techniques – Charts and Diagrams, Questioning Technique, Principals of motion Economy.

Unit III: Work Measurement **(6)**

Definition of Time study, steps in time study, Allowances, application of allowances, Calculation of standard time, work sampling, advantages of work sampling, Rating,

Unit IV: Predetermined Time Standards **(6)**

Introduction, Different types of PMTS systems, Methods Time measurement, Introduction to Most technique, Basic, Mini and maxi MOST, General move, Control Move, Tool sequence

Unit V: Job Evaluation and Merit Rating **(6)**

Introduction to Job Evaluation system, necessity, Job Analysis, Job Description, Job Evaluation, Different Job Evaluation Systems like Factor Comparison, Point System etc, merit rating, Incentive plans

Unit VI: Application of Work Study **(6)**

Application of Work Study in manufacturing and service sector, use and application of various techniques of work study, Case studies and analysis, cost savings and indirect benefits.

TEXT BOOK

1. Introduction to Work Study by ILO

REFERENCE BOOKS:

1. Yoga M., Job Evaluation, NPC, New Delhi
2. Zandin K.B. - Most Work Measurement Systems
3. Hand Book of Industrial Engineering By H.B. Maynard

Metrology and Quality Control

311104(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisite:

Basic knowledge of: Metric and SI units of physical quantities; Statistics; Trigonometry; Basics of manufacturing processes.

Course Outcomes:

At the end of the course student will be in a position to

1. Apply inspection gauge and checking systems.
2. Demonstrate the understanding of purpose of critical dimensions in manufacturing.
3. Analyze simple parts for dimensional accuracy and functionality.

Unit I: Introduction (6)

Meaning of Metrology, Precision, Accuracy, Errors in Measurement, Calibration. Linear Measurement: Standards, Line Standard, End Standard, Wavelength Standard, Classification of Standards , Precision and Non Precision Measuring instruments, Slip Gauges. Angular Measurement: Sine bar, Sine Center, Uses of sine bars, angle gauges, Auto Collimator Angle Dekkor, Constant deviation prism.

Unit II: Limits, Fits and Tolerances (6)

Meaning of Limit, Fits and Tolerance, Cost – Tolerance relationship, concept of Interchangeability, Indian Standard System.

Design of limits Gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges. Inspection of Geometric parameters: Straightness, Parallelism, Concentricity, Scariness, and Circularity. Comparators: Uses, Types, Advantages and Disadvantages of various types of Comparators.

Unit III: Surface Finish Measurement (6)

Surface Texture, Meaning of RMS and CLA values, Tomlison's Surface Meter, Taylor- Hobson Surface Meter, Grades of Roughness, Specifications. Screw Thread Metrology: External Screw Thread terminology, Floating Carriage Instruments, Pitch and flank Measurement of External Screw Thread. Gear Metrology: Spur Gear Parameters and their Inspection Methods. Interferometry: Introduction, Flatness testing by interferometry, NPL Flatness Interferometer. Study of Measuring Machines, Recent Trends in Engineering Metrology.

Unit IV : Quality Control (6)

Introduction: Meaning of Quality, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Difference between Inspection, Quality Control and Quality Assurance, Role of Quality in Present day environment. Introduction to Quality Control: 1) Meaning of quality Control 2) 100% Inspection and Selective Inspection 3) Statistics in Selective inspection. Introduction to Statistical Quality Control: Control Charts, X, R, P and C Charts, Sampling inspection, OC Curves and Sampling Plan,

Process Capability Index (PCI), Concept, Methods of determining PCI and uses of PCI.

Unit V : Quality assurance systems (6)

Quality assurance systems. Total quality management (T.Q.M):- Approaches-Deming's Approach, Juran's Approach, Cause and Effect Diagram, Pareto Analysis, Q.F.D., Quality Circles, Taguchi's quality engineering, Kaizen, six sigma, T.P.M. Technical Specification (T.S) TS 16949 Standards.

Reliability Engineering :- Concept.
Design of experiment : meaning , objective, types of research, approaches.

Unit VI: ISO Standards (6)

ISO 9001-2000 Series of Standards- History and Evolution of ISO 9000 Series , importance and overview of ISO 9000- 1998 Series standards, structure of ISO 9000-2000 Series standards, clauses of ISO 9000 series standards and their interpretation and implementation, quality system documentation and audit.
ISO 14000:- environmental management concepts, and requirement of ISO 14001 , benefits of environmental management Systems
Malcom Baldrige national quality Award and other quality awards

Text Books:

1. R.K. Jain, Engineering Metrology, Khanna Publication.
2. K.J.Hume, Engineering Metrology, Kalyani publication

Reference Books:

1. K.W.B.Sharp, Practical Engineering Metrology, Pitman Publication.
2. J.M. Juran & F.M. Gryna , Quality Planning and Analysis.
3. Juran's Quality Control Handbook.
4. I.C.Gupta, A Text book of Engineering Metrology, Dhanpat Rai and Sons.
5. E. L.Grant & R.S. Kearenworth, Statistical Quality Control.
6. Kaoru Ishikawa, Guide to Quality Control, Asian Productivity Organisation, Tokyo.
7. ISO 9000 Quality System – S.Dalela.
8. ISO 9000 Quality Management System , International Trade Center, Geneva

Product Design and Development

311105(A)-I

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theory:03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Production Management

Course Outcomes:

After Successful completion of this course students will be able to

1. Carry out the basic engineering design process and also various techniques used for a product.
2. Construct the product development process and customer requirements, QFD.
3. Evaluate the performance measure of design and DFM of a product.
4. Perform the case study of product life cycle management of a product

Unit I: Engineering Product Design (6)

Introduction to engineering design process, Industrial design, Importance of the engineering Design process, Types of designs, Engineering design process, A simplified iteration model, Design method versus scientific method, A problem-solving methodology, Considerations of a good design, Total life cycle, Regulatory and social issues, Description of design process, Conceptual design ,Embodiment design, Detail design, Planning for manufacture, Planning for distribution, Planning for use, Planning for retirement of the product.

Unit II: Embodiment Design (6)

Product architecture, Modular product architecture, Implication of Architecture, Establishing the Architecture, Product configuration and concurrent engineering, parametric design: steps, Failure Mode and Effect Analysis.

Unit III: Product Development Process (6)

Product life cycle, Generic product design process, Stage gate system of product development, Product Development process flow, Types of products, Product planning, Product planning process, Markets and marketing, Functions of marketing department, Element of marketing plan, Product development Economics.

Unit IV: Identifying Customer Needs (6)

Identifying customer needs, Voice of customers, preliminary research on customers' needs, Gathering information from customers, Customer requirements, Differing views of customer requirements, Classifying customer requirements, Kano model, Establishing the engineering characteristics, Benchmarking in general, Competitive performance benchmarking, Reverse engineering or product dissection, Determining engineering characteristics, Quality function deployment, The house of quality, Steps for building a house of quality

Unit V: Design for Manufacture (DFM) and Design for Assembly (DFA): (6)

DFM guidelines, Specific design rules, Overview of DFM process, Design of castings**:** Guidelines for the design of castings, Producing quality Castings , Design of forgings: DFM guidelines for closed-die forging, Design for sheet-metal forming: sheet metal stamping, Sheet bending, Deep drawing, Design of machining, Design for Plastic processing: Injection Molding, Estimation of manufacturing cost,

Unit VI: Product Life Cycle Management (PLM) (6)

Introduction to PLM, Opportunity & benefits of PLM, Components of PLM, PLM vision, Structure for PLM vision, PLM strategy, Product Data Management, Case studies in PLM (Auto Industry & Home appliances)

Text Books

1. Karl T. Ulrich & Steven D. Eppinger., Product Design & Development, M cGraw Hill, 3rd Edition, 2003.
2. Dieter and Schmidt , Engineering Design, McGraw – Hill Higher education, ISBN: 9780 072837032
3. John Stark, Product Life Cycle Management, 21st Century Paradigm for Product Realization, Springer

Reference Books

1. Tim Jones, Butterworth Heinmann, New Product Development by Oxford, TAC- 1997.
2. Roland Engene Y.,Inetoviez, New Product Development: Design & Analysis, John Wiley and Sons Inc., N.Y. 1990.
3. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
4. Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
5. Boothroyd & Dewburst P.,Design for Assembly, a Designer's Hand book, University of Massachusets, Amherst, 1983.
6. Keyinotto and Kristini Wood, Product Design Pearson Education 2004.
7. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub. 1986
8. ISO Standard: 9001:2008: Clauses 7.1, 7.2, 7.3

Nano Manufacturing

311105(A)-II

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme**:
Lectures: 3 Hrs./Week	Theory: 3	In-Sem Exam: 30 Marks
		End-Sem Exam: 70 Marks

Course Outcomes

After completing the course, students will be able to:

1. Identify different techniques used in micro-nano machining
2. Use conventional techniques used in micro-nano manufacturing
3. Demonstrate the concept of non-conventional micro-nano manufacturing and finishing approaches
4. Select nanofabrication Techniques and other processing routes micro-nano manufacturing
5. Apply metrology tools used in micro-nano manufacturing

Unit I: Ultra-precision Machining Processes (6)

Introduction to nano-scale material removal process analysis, Ductile Mode Cutting of Brittle Materials, Advances and recent developments in material removal processes, Precision (micro and nano) machining processes, Applications of precision Turning, Drilling, Milling and Grinding processes, Cutting tools and instrumentation used in precision (micro and nano) machining processes, use of Diamond Tools in Micromachining,

Unit II: Ultra-precision Forming Processes (6)

Introduction to precision (micro and nano) forming processes, Applications of precision forging, Plastic forming and Roller Imprinting, extrusion, sheet metal forming and hydroforming, tools and instrumentation used in precision (micro and nano) forming processes.

Unit III: Non-conventional micro-nano machining (6)

Introduction to Non-conventional micro-nano manufacturing Processes, principle and applications of – Abrasive Jet Micro Machining, WAJMM, Micro EDM, Micro WEDM, Micro EBM, Micro ECM, Micro LBM, Fundamentals of lasers, Laser micro-fabrication, Laser nanofabrication.

Unit IV: Nano Finishing Processes (6)

Introduction to Nano Finishing Processes, Magneto-rheological Finishing (MRF) processes, Magneto-rheological abrasive flow finishing processes (MRAFF) – process principle and applications, Elastic Emission Machining (EEM) – machine description, applications, Ion Beam Machining (IBM) – principle, mechanism of material removal, applications, Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications

Unit V: Micro-nano Fabrication (6)

Introduction to Micro and Nano Fabrication: basics, flowchart, basic chip making processes, Introduction to Nanofabrication, Nanofabrication using soft lithography– principle, applications, Introduction to Carbon nano materials – CN Tubes properties and applications

Unit VI: Micro-nano Measurements (6)

Introduction to micro and nano measurements, defining the scale, uncertainty Scanning Electron Microscopy – description, principle, Optical Microscopy– description, application, Scanning Probe Microscopy, scanning tunneling microscopy description, application, Introduction to On-Machine Metrology

References:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V.K. Jain, Micro-manufacturing Processes, CRC Press, 2012.
5. J. Paulo Davim, Mark J. Jackson Nano and Micro machining, John Wiley & Sons, 2013
6. Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
7. Kapil Gupta, Micro and Precision Manufacturing, Springer, 2017

Statistics and Numerical Methods

311105(A)-III

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory:03	In-sem Exam: 30 End-sem Exam: 70

Prerequisites: Engineering Mathematics- I and II, Design of Machine Elements

Course Outcomes:

After studying the subjects students will be able to

1. Apply statistical methods to production engineering problems
2. Relate numerical methods to production engineering
3. Develop model of physical problem and subsequent solution by appropriate optimization method

Unit I : Statistical hypothesis and tests **(6)**

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

Unit II: Design and Analysis of Experiments **(6)**

Design and Analysis of Experiments: Importance of experiments, Experimental strategies, Basic Principles of Design Terminology, ANOVA, steps in experimentation, two and three full Factorial experiments, Taguchi Methods, Design using Orthogonal Arrays, S/N ratios, Data Analysis

Unit III : Errors & approximations analysis **(6)**

Errors & approximations: types of errors, error propagation. Numerical solution of algebraic and transcendental equations by bisection method.

Newton Raphson Method. Numerical solution of Linear Simultaneous Equations by Gauss Elimination Method, Gauss-Siedel Method.

Unit IV : Methods of curve fitting **(6)**

Numerical methods - Curve Fitting, methods of curve fitting. Least square criterion- 1st and 2nd order Interpolation: Lagrange's formula, Newton forward difference method. Methods of moment for curve fitting.

Unit V : Numerical Differentiation **(6)**

Interpolation, Newton's forward and backward difference interpolation, Numerical Differentiation and Numerical Integration, Lagrange's and Newton's divided difference, Approximation of derivatives using interpolation, polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules

Unit VI : Optimization Methods **(6)**

Manufacturing Optimization- Method of Lagrange multipliers, steepest descent method, Introduction of classical optimization and multiple optimization. Generalized reduced gradient Method. Introduction to GA and SA. Case studies.

Reference Books:

1. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and sons inc. New York 8th edition.
2. S.C. Chapra, R.P. Canale, —Numerical Methods for engineers with programming and software applications, Tata McGraw Hill Co. Ltd, New Delhi,
3. Dr. Sadhu Singh, Computer aided Design and Manufacturingll, Khanna Publication, New Delhi.
4. Ramin S. Esfandiari, Numerical Methods for Engineers and Scientists Using MATLAB, CRC press, Taylor and Francis group.
5. Jaan Kiusalaas, Numerical Methods in Engineering with Matlab, Cambridge University press.

Financial Management and Costing

311105(A)-IV

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theroy: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Pre-requisites: Industrial Engineering & Management, Production Management

Course Outcomes:

After learning this subject, the student will:

1. Use Financial Statements to evaluate firm performance.
2. Calculate time value of money and Cost of Capital.
3. Demonstrate how materials, labor and overhead costs are added to a product at each stage of the production cycle.
4. apply cost accounting techniques and evaluate their limitations;
5. use and evaluate appropriate costing and decision making techniques to make short term decisions;
6. use standard costing systems to undertake a performance review and interpret the results

Unit I: Financial Management **(6)**

Financial function, Scope, goals and tools. Sources of finance, corporate planning and financial management. Financial Statements: Balance sheet, profit and loss account. Ratio Analysis: Classification, Ratio Analysis and its limitations. Operating and Financial Leverage.

Unit II: Capital Budgeting **(6)**

Control of Capital Expenditure, Evaluation Process-Payback approach, Accounting of Rate of

Return, Present Value Method Vs Internal Rate of Return. Replacement cost and discounted cash flow.

Unit III: Working Capital Management **(6)**

Concept and design of Working Capital, types of working capital, sources of working capital, time value of money, cost and capital, cost of capital. Funds Flow Analysis: Concepts, Objectives, and Techniques of Funds Flow Statement.

Unit IV: Costing **(6)**

Methods of costing and elements of cost. Material Cost: Different methods of pricing of issue of materials. Material losses - Wastage and its consideration. Labour Cost: Different methods wages and incentive plans. Principles of good remunerating system, labour turnover and its methods.

Depreciation: Concept, importance and different methods of depreciation. Estimation of material, machining and labour cost machining. Overheads: Classification, collection of overheads, Primary and Secondary apportionment of overheads, absorption of overheads. Machine hour and labour hour rate. Under and over absorption of overheads. Estimation of overheads.

Unit V: Standard Costing and Variance Analysis: **(6)**

Concept, development & use of standard costing. Material, Labour, Overhead, Sales. Profit, Product-mix and Yield Variance. Cost control: Capital cost control-the nature of control, elements of cost control programme, project planning and scheduling, cost reporting and corrective action. Capital cost control repetitive operating cost, standard costs, cost reporting and corrective action.

Unit VI: Types of Costing Methods (6)

Marginal Costing: Concept, Use of Marginal Costing in decision-making Activity based costing: Concept, cost drives, applications. Process costing: Concept, transfer cost, concept of by products, joint costing, scrap, waste, losses, cost of quality.

Text Books:

1. N. K. Prasad, “Principles and Practice of Cost Accounting”, Syndicate Pvt. Ltd., Calcutta
2. M. Pandy, “Financial Management”, New Delhi Vikas Publication House Pvt. Ltd., ISBN 81-259-0638
3. M. Y. Khan, P. K. Jain, “Financial Management”, Tata McGraw Hill Publishing Ltd.
4. B. K. Bhar, “Cost Accounting Methods and Problems”, Academic Publishers, Calcutta

Reference Books:

1. Henry M. Steiner, “Engineering Economics Principles”, McGraw Hill Publication.
2. C.B. Gupta, “Fundamentals of Business”, Sultan Chand & Co.,
3. P. A. Samualson, “Economics”, McGraw Hill International.
4. K. K. Dewett, “Modem Economic Theory”, Sultan Chand & Co., ISBN 81-219-0331-1
5. Colin Drury, “Management and Cost Accounting”, English Language Book Society, Chapman & Hall London.

Metrology and Quality Control

311101(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical : 01	Practical: 50 Marks

List of Practical

The Term work should be in the form of Journal consisting of following Two sections:

Experiments: (Any seven of the following)

1. Measurement of straightness, flatness, roundness.
2. Measurement of the Surface roughness.
3. Measurement of angle by sine bar / Sine center.
4. Measurement of Optical surface using Interferometer.
5. Measurement of Screw thread parameters using Floating Carriage Micrometer.
6. Measurement of Gear tooth thickness using Gear tooth Vernier caliper and Span Micrometer.
7. Study and Experiment on Profile Projector.
8. Study and Experiment on any type Comparator.
9. Calibration of instrument using Calibration setup.
10. Alignment Test on Lathe / Drilling / Milling Machine
11. Experiment to measure Process Capability using Statistical Process Control.

Assignments:

1. Design of Sampling Plan
2. Design of Control Charts
3. Assignment on Process Capability
4. Case Study on 7 QC Tools
5. Case on Constructing House of Quality for any Product

Production Practice-IV

311102(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical : 01	TW : 25Marks

Each candidate shall be required to complete and submit the following term work.
Composite job involving different machining operations.

Part A:-

1. **Lathe:** external and internal threading (Vee, Square or Acme threads), taper turning, grooving, knurling, drilling operations on lathe.
2. **Milling**: helical or bevel gear cutting on a milling machine.

Part B:- Journal consisting of :

1. Preparation of journal consisting of calculation and procedure for above gear cutting on milling machine.
2. Safety aspects used in the machine shop:- Precautions and care to be taken while working on various machine tools e.g. lathe, milling, drilling, grinding etc.

Note: - A practical examination of 12 hours duration shall be conducted at the end of semester based on the part A

Computer Programming and Applications

311103(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical: 01	TW:25 Marks

Any 6 of the following 10 experiments have to be performed:

1. Prepare forms for accepting database of students in Visual Basic
2. Write programs for simple calculator, alarms digital/analog clock
3. Use of various controls in VB through programming: list box, scroll, check box, option, use of array, text boxes, viewing files on the computer, etc.
4. Creation of database for accepting bio-data of students
5. Write program to integrate 1 & 4 above
6. Prepare an application for the department library
7. Prepare an application that takes care of continuous assessment of students
8. Prepare a program that can save day wise events / day planner
9. Write a programme for the Class test marks analysis system.
10. Write a programme for the Calendar

Work Study Lab

311104(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical : 01	Oral:25 Marks

Any 8 of the following assignments have to be completed by a student and journal to be prepared.

List of Assignments

1. Single facility location problems – Quantitative Techniques
2. Multiple facility location problems - Quantitative Techniques
3. Case on – Facility Location
4. Assignment on Process Layout - REL Charts
5. Assignment on Product Layout - Line Balancing
6. Computerized Layout Planning
7. Assignment on Layout Evaluation Techniques
8. Comprehensive Case on – Layout Improvement 1
9. Comprehensive Case on – Layout Improvement 2
10. Comprehensive Case – Material Handling Systems Design 1
11. Comprehensive Case – Material Handling Systems Design 2
12. Industrial Visit

Product Design & Development Lab

311105(B)-I

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical : 01	Oral: 25 Marks

Term work will be based on any six assignments from following;

1. Morphological analysis of product design
2. Quality Function Deployment (QFD) and House of Quality
3. Case study based on product design approach
4. Case study of FMEA
5. Product Tear Down approach in product design
6. Design for –X
7. Case study in Product Life cycle Management (PLM)
8. Case study on identification of customer needs for specific product

Nano Manufacturing Lab

311105(B)-II

Teaching Scheme:	**Credit Scheme:**	**Examination Scheme**:
Practical: 2 Hrs./Week	Practical: 1	Oral Exam: 25 Marks

Each candidate shall be required to complete and submit the following term work.

Term Work

Term work will be based on following practical/design assignments

1. To demonstrate Theory, Modeling, and Simulations of any one of the conventional techniques used in micro-nano manufacturing
2. To demonstrate production of prototype devices and examples of commercially viable products at nano scale functionality.
3. To demonstrate Theory, Modeling, and Simulations of any one of the Non-conventional techniques used in micro-nano manufacturing
4. To develop prototype of nano-device that confirm the effectiveness of the design concept and demonstrate the feasibility toward future commercialization.
5. To study features and phenomena at the nanoscale which requires instruments capable of resolutions at the nano-, subnano-, and even pico-levels such as: Scanning Electron Microscope, Atomic Force Microscope, Scanning Tunnelling Microscope.

Statistics and numerical methods lab

311105(B)-III

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical:01	Oral: 25 Marks

Each candidate shall be required to complete and submit the following term work.

1. Practical on parameter optimization of any one process using Taguchi based design of experiment. Validation of results using any statistical software (R/Minitab/Excel/SigmaXL/Statgraphics etc.).
2. Practical on determination of significant factors for any one process using ANOVA. Validation of results using any statistical software. (R/Minitab/Excel/SigmaXL/Statgraphics etc.).
3. Practical case study on regression analysis. (Data should be collected for some real life case). Validation of results using any statistical software. (R/Minitab/Excel/SigmaXL/Statgraphics/Matlab etc.).
4. Practical case study on regression analysis. (Data should be collected for some real life case).
5. Practical case study on multivariable optimization with constraint using any one method.
6. C programming for any 3 practical mentioned above.

Financial Management and Costing Lab

311105(B)-IV

Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Lectures: 02 hours / week	Pr/Or: 01	Oral: 25 Marks

Numerical Based Assignments using MS-Excel/MS Project/Talley etc.

1. Preparation of Financial Statements and Ratio Analysis for any industry,
2. Assignment on Payback approach, Accounting of Rate of Return, Present Value Method and Internal Rate of Return.
3. Assignment on Working Capital Management
4. Assignment on Material Cost, Labor Cost, Depreciation and Overheads
5. Assignment on Standard Costing and Variance Analysis
6. Assignment on Marginal Costing, Activity based costing and Process costing

Seminar

311106

Teaching Scheme Scheme	**Credit Scheme**	**Examination**
Seminar: 1 hours / week	Seminar: 01	TW: 50 Marks

1. The objective of Seminar is to test the student on his/her ability for self-study and his/her ability to communicate - Written and oral.

2. Seminar will be in the form of a report submitted by the student:

   a) On topic of his/her choice based on literature survey/ a case study wherever applicable/possible, and approved by the staff- in- charge.
   b) A report with 20-25 pages of A-4 size paper, 1.5 spaced typed material, and appropriately bound.
   c) Title font/figures/graphs shall be black and white.

3. The term work evaluation will be based on the report submitted and (orally) presented.

Audit Course 5:

Disaster Management

311107

The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.

Course Contents:

1. Different Types of Disaster: Natural and man made
2. Risk and Vulnerability Analysis
3. Disaster Preparedness
4. Disaster Response
5. Reconstruction and Rehabilitation as a Means of Development.
6. Damage Assessment
7. Post Disaster effects and Remedial Measures.
8. Long-term Counter Disaster Planning

Audit Course 5:

Industrial Waste management

311107

Introduction: Characteristics of industrial wastes, Types of industries and industrial pollution, Population equivalent, Bioassay studies, effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health, Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.

Waste management Approaches: Waste Audit, Volume and strength reduction, Material and process modifications, Recycle, reuse and byproduct recovery – Applications.

Treatment technologies: Equalization, Neutralization, Removal of suspended and dissolved organic solids, Chemical oxidation, Adsorption, Removal of dissolved inorganics, combined treatment of industrial and municipal wastes, Residue management, Dewatering, Disposal

References:

1. Zander Elis,, Industrial Waste Management, Larsen and Keller Education, 2017, ISBN: 9781635491494
2. John P. Samuelson, Industrial Waste: Environmental Impact, Disposal and Treatment, Nova Science Publishers, 2009, ISBN: 9781606927205

Operations Research

311108(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Students need to have understanding of mathematics, statistics and probability

Course Outcomes:
Students will be able to
1) State definitions, features, applications and limitations of Operations Research.
2) Formulate Linear Programming Problem.
3) Solve LPP using various methods like graphical and simplex technique.
4) Formulate and solve transportation problem.
5) Formulate and solve assignment and scheduling problem.
6) Carry out replacement analysis to decide optimum replacement period.
7) Solve game problems using various methods.

Unit I: Introduction & Formulation Of LPP Model **(6)**
OR methodology, Definition of OR, Application of OR to engineering and Managerial problems, Features of OR models, Limitation of OR, formulation LPP Models.

Unit II: Linear Programming **(6)**
Definition, mathematical formulation, standard feasible, basic feasible, optimal, infeasible, Degeneracy. Graphical and simplex methods. Artificial basis techniques, Big M Method, form, solution space, solution – multiple, optimal, Redundancy, Variants of simplex algorithm

Unit III: Transportation Problem **(6)**
Formulation of transportation model, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel's Approximation Method) Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Variants in Transportation Problems, Applications of Transportation problems. Transshipment problems.

Unit IV: Assignment Problem & Scheduling **(6)**
Formulation of the Assignment problem, unbalanced assignment problem, various methods of job shop scheduling.

Unit V: Replacement Analysis **(6)**
Replacement of capital equipments that deteriorates with time, time value of money (a) remains same (b) changes with constant rates during period. Equipment renewal policy, group and individual replacement. Individual Replacement, Group Replacement Policies, Problems.

Unit VI: Games Theory **(6)**
Introduction, two -person zero sum game, minimax and maximin principle, saddle point, methods for solving game problems with mixed strategies, Graphical and iterative methods, solving game by LP Method.

Text Books

1. P. K. Gupta & D. S. Hira: Operations Research, S. Chand & Co.
2. Paneerselvam: Operations Research , Prentice Hall of India Reference Books
3. Taha H A : Operation Research and Introduction, McMillian.ISBN-0-02-418940-5
4. Hiller and Libermann: Introduction to Operation Research, McGraw Hill 5th edn.
5. S.D. Sharma – Operations Research, Kedarnath, Ramnath &Co
6. J K Sharma, Operations Research Theory and Application, Pearson Education Pvt Ltd.
7. Kanthi Swarup, Gupta P. A., Manmohan, Operations Research, Sultan Chand and Sons.

Ergonomics and Product Design

311109(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Design of machine elements & Material Science.

Course Outcomes:
At the end of the course student will be in a position to

1. Identify the product design methodology & approaches.
2. Demonstrate knowledge on basic design process used in new product.
3. Understand the value engineering in product design.
4. Apply ergonomics in product & work station design.

Unit I: Product methodology & the structure of Design Process (6)
Introduction of Product methodology, methodological problems, characteristics of methods, the phases of product design process, foundations of phase models, three phase models etc.

Unit II: Design materials & human factors in product design (6)
Material properties, metals, plastics, rubber, woods & factors considered while designing for metals, plastics, rubber, woods etc, Anthropometry factors, physiological factors, psychology factors, anatomy factors.

Unit III: Economic factors influencing design (6)
Product value, safety, reliability & environmental considerations, economic analysis, break even analysis, profit & competitiveness, economics of a new product design.

Unit IV: Value engineering in product design (6)
introduction, historical perspective, nature & measurement of value, importance of value, value analysis job plan, creativity, steps for solving & value analysis, value analysis tests.

Unit V: Ergonomics (6)
Definition, Scope, Historical background, Human- machine system interfaces, Basic Ergonomics, Work Physiology, Measurement of work, Introduction to Environmental Ergonomics.

Unit VI: Applied Anthropometry (6)
Definition and scope, use of anthropometric data, statistical analysis, Product design and work station design using anthropometric data, Work Space design.

Text Books:

1. A.K.Chitale, R.C Gupta, “Product design & Manufacturing”
2. N.F.M. Roozenburg & J.Eekels, “Product Design : Fundamentals & Methods”
3. Introduction to Work Study by ILO
4. Sanders McCormick, “Human Factor Engineering and Design”

Reference Books:

1. Jhon R Lindbeck, “Product design & Manufacture”
2. Mayall W.H., “Industrial Design for Engineers” London Liifee Books Ltd.
3. Dale Huchingson R “New Horizons for Human Factors in Design ” McGraw Hill Company

4. Job Evaluation – ILO
5. Yoga M., Job Evaluation, NPC, New Delhi
6. Zandin K.B. - Most Work Measurement Systems
7. H.B. Maynard, Hand Book of Industrial Engineering

Facilities Planning

311110(A)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites: For successful completion of the course student must have

1. The knowledge of basic manufacturing processes and equipments.
2. The knowledge of basic operation sequence.
3. Basic Analytical skill to analyze the facility planning data.

Course Outcomes: On successful completion of course the student should have

1. Knowledge and understanding of design, selection and installation of plant layout according to product.
2. The ability to systematic material handling analysis.
3. Knowledge of approach, terminology and scope of facility maintenance.
4. Knowledge of the use of computer in facility planning.

Unit I : Scope of Plant Engineering **(6)**

Plant Layout – Introduction, Types of Plant Layout, Phases of Layout Planning, Plant Location, Urban v/s Rural Location.

Unit II: Systematic Layout Planning **(6)**

P-Q Analysis, Flow of Materials Analysis, Activity Relationship Analysis, Space Requirements & Availability, Modifying Considerations, Practical Limitations, Selection of Layout, Installation of Layout.

Unit III: Material Handling Function **(6)**

Principles of Material Handling, MH Equipment – Conveyors, MH Equipment – Cranes, MH Equipment – Trucks.

Unit IV: Systematic Handling Analysis **(6)**

External Integration, Classification of Materials, Layout Considerations, Analysis of Moves, Visualization of Moves, Flow Diagram – DI Plot, Preliminary Handling Plans, Modifications & Practical Limitations, Calculation of Requirements, Evaluation of Alternatives, Installation.

Unit V: Maintenance Function **(6)**

Types of Maintenance, TPM – Introduction, TPM Pillars, 5S Technique, Overall Equipment Effectiveness.

Unit VI: Dynamic layout planning **(6)**

Introduction to Dynamic Layout planning, Optimization in layout planning, Computerized Layout Planning, CORELAP, CRAFT, ALDEP.

Text Books

1. R.L Francis and J.A White (1974), Facilities layout and location-An analytical approach, Prentice Hall Inc.

2. J.A Tomkins and J.A White (1984), Facilities Planning, John Wiley & sons.

Reference Books

1. M.E Porter (1985), Competitive Advantage, The Free Press.
2. D.K. Carr and H.J Johansson (1995), Best practices in Reengineering, McGraw Hill, Inc.
3. K.K.Humphreys (1991), Jelen's Cost and Optimization Engineering, McGraw Hill, International.
4. P.Cheekland (1981), Systems thinking, Systems Practice, John Wiley & sons.
5. B.W. Niebel (1972), Motion and Time study, Richard Irwin.
6. L.D.Miles (1971), Techniques of Value analysis and Engineering, McGraw Hill.
7. K.Hitomi (1996), Manufacturing Systems Engineering; Viva Books Pvt Ltd, India.
8. A.W. Law and W.D.Kelton (1991), Simulation Modeling and Analysis, McGraw Hill International Edition
9. G.F.Bell and J Balkwill (1998), Management in Engineering, Prentice Hall India.
10. J.M.Apple (1972), Plant Layout and Material Handling, McGraw Hill.

Finite Element Analysis

311111(A)-I

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theroy: 03	In-Sem: 30 Marks End-Sem: 70 Marks

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Prerequisites: Fundamentals of Programming Language, Engineering Mechanics, Strength of Material, Kinematics of Manufacturing Machines, Design of Machine Elements, Heat and Fluid Engineering

Course Outcomes

After successful completion of course student will able to,

1) Model and Analyze 1-D problem.
2) Model and Analyze Truss subjected to loading
3) Model and Analyze Two-Dimensional Problem Using Constant Strain Triangles
4) Perform finite element modeling of triangular element and 2-D iso-parametric elements
5) Analyze steady state heat transfer - 1D and 2D heat conduction and convection
6) Identify meshing techniques quality aspects of meshing

Unit I: Introduction **(6)**

Introduction, One Dimensional Problem, Finite Element modeling, Coordinate and Shape function, Derivation of stiffness matrix and Load Vector using Potential Energy approach, Properties of Stiffness Matrix, Assembly of Global Stiffness Matrix and Load Vector, Elimination and penalty approach, shape function, Quadratic Shape Function.

Unit II: Trusses **(6)**

Introduction to different approaches used in FEA such as direct approach, Variational approach,weighted residual, energy approach, Galerkin and Raleigh Ritz approach,Introduction to Plane trusses, Assembly of global Stiffness Matrix for Banded Skyline solutions.

Unit III: Two-Dimensional Problem Using Constant Strain Triangles **(6)**

Introduction, finite element formulation, load considerations and boundary conditions, problem modeling, member end forces, plane frame.
Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal's triangle , primary and secondary variables, properties of shape functions.

Unit IV: Axi-symmetric solids subjected to axi-symmetric loading **(6)**

Introduction, axi-symmetric formulation, finite element modeling of triangular element

Two dimensional iso-parametric elements

Introduction, four node quadrilateral, introduction to higher order elements.

Unit V: Finite element analysis of heat transfer **(6)**

Introduction, steady state heat transfer - 1D and 2D heat conduction and convection, governing differential equation, boundary conditions, formulation of element.

Unit VI: Dynamic analysis **(6)**

Types of dynamic analysis, General dynamic equation of motion, point and distributed mass, lumped and Consistent mass, Mass matrices formulation of bar and beam element. Undamped-free vibration- Eigenvalue problem, Evaluation of eigenvalues and eigenvectors (natural frequencies and mode shapes).

Text Books

1. Daryl L. Logan, A First Course in the Finite Element Method,
2. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis, Wiley-India

Reference Books

1. Chandrupatla T. R. and Belegunda A. D., —Introduction to Finite Elements in Engineering, Prentice Hall (I)
2. Seshu P., —Text book of Finite Element Analysis‖, PHI Learning Private Ltd. New Delhi, 2010.
3. Bathe K. J., —Finite Element Procedures‖, Prentice-Hall of India (P) Ltd., New Delhi.
4. Fagan M. J., —Finite Element Analysis, Theory and Practice‖, Pearson Education Limited
5. Kwon Y. W., Bang H., —Finite Element Method using MATLAB‖, CRC Press, 1997
6. S. Moaveni, —Finite element analysis, theory and application with Ansys,
7. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill
8. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., —Practical Finite Element Analysis, Finite to Infinite, Pune

Advances in Manufacturing Processes

311111(A)-II

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 03 hours / week	Theroy: 03	In-Sem: 30 Marks End-Sem: 70 Marks

Prerequisites: Manufacturing process I

Course Outcomes:

Students will be able to:

1. Classify and compare various mechanical based unconventional machining processes
2. Classify and compare various thermal & chemical energy based non- conventional machining processes.
3. Evaluate & select suitable advanced casting process for wide variety of application
4. Understand advanced welding process.
5. Understand the advanced fine finishing process
6. Evaluate & select suitable advanced material forming process for wide variety of application

Unit I: Unconventional Machining Processes-I (6)

Need & types of non-conventional methods & importance of methods, Principle of working, equipment, Mechanism of material removal, Process parameters, performance characterization, Applications of following process such as Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive Water jet machining(AWJM), Ultrasonic machining(USM).

Unit II: Unconventional Machining Processes-II (6)

Principle of working, equipment, Mechanism of material removal, Process parameters, performance characterization, Applications of following process such as Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes, working principal of Plasma arc machining

Unit III: Advanced Casting Processes (6)

Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting

Unit IV: Advanced Welding Processes (6)

Heat Flow in Welding: Calculation of peak temperature; Width of Heat Affected Zone (HAZ); cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

Weld Design: Types of welds & joints, Joint Design, Welding Symbols, weld defects, Inspection/testing of welds, Introduction to Welding Procedure Specification & Procedure Qualification Record.

Unit V: Advanced Fine Finishing Process (6)

Magnetic Abrasive Finishing (MAF), Magneto Rheological Abrasive Finishing (MRAF) - Process principle; Process equipment; Process Parameters; Process Capabilities; Applications; Limitations

Unit VI: Special manufacturing processes (6)

Broaching: Types of broaching machines. Parts of the machines and their functions. Components machined on broaching machine. Broach geometry.

Gear Manufacturing: Gear cutting processes- Gear hobbing, Gear shaping, Gear shaving, Gear lapping and gear grinding. Construction and working of the machines.

Thread Manufacturing; Thread cutting, chasers and dies. Thread milling, thread rolling, thread lapping and thread Grinding

Text Books:

1. HMT, —Production Technology
2. Chapman; —Workshop Technology, Edward Arnold Publishers, ISBN 0 7131 3287 6
3. P. N. Rao, —Manufacturing Technology, Tata McGraw Hill, ISBN 0 07 451863 1.
4. Richard L. Little, Welding and Welding Technology, by-, McGraw Hill Education, ISBN:
5. R. S. Parmar, Welding Engineering and Technology, Khanna Publishers, ISBN:

Reference Books:

1. P C Sharma; —Production Technology (Manufacturing Processes), S Chand & Co., ISBN 81 219 114.
2. Kalpakjian S, —Manufacturing Engineering and Technology, Pearson Education.
3. Pabla Adithan, —CNC Machines, New age International Pub, ISBN 81 7808 157 1
4. Kundra B S, P N Rao, M Tiwari; —Numerical Control and Computer Aided Manufacturing —TATA McGraw Hill Pub. ISBN 0 07 4517 40 6.
5. Mikell P. Groover; —Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Ltd, Delhi, ISBN 81 203 0618 X
6. Pandey, Shan; —Modern Machining Processes.
7. Ghosh Amitabh, A. Malik; —Manufacturing Science, East-West Press Pvt. Ltd.,
8. P.N. Rao, —CAD/CAM/CIM Principles, Tata McGraw Hill Publication,
9. V.K. Jain, “Advanced Machining Processes” Allied Publishers Pvt. Ltd.
10. P.C Pandey & H.S. Shan, “Modern Machining Processes” McGraw Hill Education.
11. E. P. DeGarmo, J. T Black, R. A. Kohser, "Materials and Processes in Manufacturing" (8th Edition) Prentice Hall of India, New Delhi.
12. G.F. Benedict, Marcel Dekker, "Nontraditional Manufacturing Processes" Inc. New York.
13. Mishra P K “Non-Conventional Machining”, Narosa Publishers.
14. Singh K K “Unconventional Manufacturing Processes” Dhanpat Rai & Company, New Delhi.
15. H. Abdel and G. El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes,1st edition, McGraw-Hill Professional, 2005. ISBN: 978- 0071453349

Mechatronics

311111(A)-III

Teaching Scheme Scheme	Credit Scheme	Examination
Lectures: 3 hours / week	Theory: 3	In-Sem: 30 Marks End-Sem: 70 Marks

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Course Outcomes:

After learning this subject, the student will:

1. Understand the control system basics and the types of control systems
2. Apply knowledge of response specifications of control system.
3. Use controller principles for composite modes of control
4. Be able to do PLC programming, programming with counters and timers, real time PLC programming examples.
5. Apply the Mechatronics system, actuators, sensors and transducers used digital signal processing in real life problems

Unit I: Sensors and Transducers (6)

Introduction to Mechatronics, Open and Closed loop control system, Block Diagram Algebra With respect to Types, Range, and Applications and limitations, Thermocouples, Thermistors and Resistance Temperature Detectors With respect to Construction, Working and Applications, Linear Variable Differential Transducer. With respect to Principle, Types, and Applications, Strain Gauges, Gauge Factor and Measurement of Strain With respect to construction, working and specifications Electromagnetic Flow meter. With respect to specifications and applications, Capacitive and Inductive Proximity sensors Angular Velocity measurement, Tacho generators, Rotary Encoders

Unit II: Analog Signal Conditioning (6)

Passive Circuits, Voltage dividers, Wheatstone's bridge, Low pass, high pass and bandpass filters. Op-Amps, Characteristics and Specifications, Voltage Follower, Inverting Amplifier, Non Inverting Amplifier, Summing Amplifier, Instrumentation Amplifier, Integrator, Differentiator. Current To Voltage Converter, Current to Voltage Converter Numerical Examples based on Wheatstone's Bridge and Op-Amps

Unit III: Interfacing (6)

Logical Gates, Boolean Algebra, Binary, Octal and Hexadecimal Number Systems and their significance. Analog to Digital Conversion SAR & R-2R Digital to Analog Conversion Sample and Hold Circuits, Sampling Theorem, Samplifing Frequency, Quantization. Numerical Examples based on ADC, DAC and Sampling

Unit IV: Modelling and Analysis (6)

Process Control Basics, Control System Parameters Process Dynamics Laplace Transform Basics, Dead Time Responses in Laplace Form Lag Responses in Laplace Form, Types of Second-Order Response

Unit V: Control System (6)

Controller Actions, Proportional Controllers (P Mode), Integral Controllers (I Mode) with examples of plotting controller action vs time for respective error time plot Proportional-Integral Controllers (PI Mode) with examples Derivative Controllers (D Mode) Proportional-Derivative Controllers (PD Mode) with examples Proportional-Integral-Derivative Controllers (PID Mode) with examples

Unit VI: PLC Programming **(6)**

Introduction to PLC Programming, Types of PLC Languages, Ladder Diagram Format, Ladder Relay Instructions, Ladder Relay Programming, Timer Instructions with example Counter Instructions with example

Text Books

1. C D Johson, Process Control Instrumentation Technology, 7/e., Prentice Hall of India Pvt. Ltd. 2005.
2. L. A. Bryan, E. A. Bryan, Programmable Controllers: Theory and Applications, Industrial Text Company Publications, 2/e

Reference Books

1. Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, Mc-Graw Hill publication, 2011.
2. Bishop (Editor), Mechatronics – An Introduction, CRC Press, 2006

Materials Management

311111(A)-IV

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 3 hours / week	Theory: 03	In-Sem: 30 Marks End-Sem : 70 Marks

Outcomes:

At the end of the course, student will be able to

1. Demonstrate the concepts of inventory management
2. Identify suitable replenishment method for given application.
3. Evaluate the cost of inventories
4. Apply the concepts of manufacturing resource planning to real life problems

Unit I: Introduction to Materials Management (6)

What are Inventories, need of inventories, objectives of an Inventory Control system, concept of Rate of Return with respect to Inventories, Symptoms of poor Inventory management, Purchase procedure.

Unit II: Classification and Costs of Inventories (6)

Different types of Inventories, Inventory carrying cost, procurement cost, set up cost, stock out cost, Inventory cost curve, problems based on inventory costs, EOQ concept, assumptions of EOQ model, mathematical treatment of economic buying, Extension of basic EOQ model.

Unit III: Selective Inventory Control (6)

Concept of Selective Inventory Control, ABC analysis, VED analysis, HML analysis, SDE analysis, SOS analysis, FSN analysis, GOLF analysis, Concept of Lead time and its effects on Inventory, Internal and External lead time, Elements of lead time, Evaluation and ways to minimize lead time, Vendor development and vendor rating.

Unit IV: Replenishment Systems (6)

Introduction, Different types of replenishment systems like Fixed order quantity system, Fixed order interval system, Combination of fixed order interval and quantity system, Tow Bin System, Safety stocks.

Unit V: Surplus and Obsolescent stocks (6)

Introduction, Genesis of surplus materials, Disposal of surplus and obsolete materials, need of physical stock taking, method of stock taking like annual, continuous, reorder point stock taking, Inventory records.

Unit VI: Manufacturing Resource Planning (6)

Why Inventory control is an integrated approach? Concept of Manufacturing Resource Planning (MRP), MRP I and MRP II, case studied in MRP, Introduction to ERP.

Text Book

1. L.C. Jhamb, Inventory management

Reference Books:

1. Lee L., Dobler D. W., and Burt, D.N, Purchasing & Supply Management, McGraw-Hill Inc.,US
2. Silver, Pyke and Peterson, Inventory management and Production Planning & Scheduling, John Wiley and Sons

Operations Research Lab

311108(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical : 2 hours / week	Practical : 01	Practical : 50 Marks

Any 8 of the following assignments have to be completed by a student and journal to be prepared.

List of Assignments

1. Formulation of L. P. Problem
2. Solving L. P. Problem
3. L. P. problem based on redundancy and degeneration
4. Transportation problem using Vogel's approximation
5. Graphical Method or North West Corner method
6. Assignment problem
7. Unbalanced assignment problem
8. Individual Replacement
9. Group Replacement
10. Games theory

Ergonomics and Product Design Lab

311109(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2hours / week	Practical : 01	TW : 25 Marks

The following assignments have to be completed by a student and journal to be prepared.

List of Assignments

1. Anthropometric Data collection
2. Anthropometric data analysis
3. Ergonomic Design analysis of a consumer durable
4. Ergonomic Design analysis of an engineering equipment
5. Ergonomic Design analysis of a Fast Moving Consumer Good packaging
6. Ergonomic Design analysis of a work place

Facility Planning Lab

311110(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical : 01	TW : 50 Marks

The following assignments have to be completed by a student and journal to be prepared.

List of Assignments

1. One assignment of each Unit.
2. Computer aided plant layout: At least one software based assignment
3. Industrial visit report

Finite Element Analysis Lab

311111(B)-I

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Theory: 01	Oral : 50 Marks

Term work shall consist of following Practical's

1 Computer program for axial bar subjected to axial forces.
2 Computer program for truss subjected to plane forces.
3 Computer program for beams subjected to transverse forces and moments
4 Computer program for frames subjected to transverse forces and moments
5 Stress and deflection analysis of two dimensional truss using FEA software
6 Stress and deflection analysis of any machine component consisting of 2-D elements using FEA software.
7 Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software
8 Modal analysis of any machine components.
9 Computer program for 1-D temperature analysis
10 Thermal analysis of member subjected to loading
11 Shear force and Bending Moment Calculations of Shaft using FEA software
12 Analysis of component subjected to self weight
13 Thermal analysis of composite wall

Advances in Manufacturing Processes-Lab

311111(B)-II

Teaching Scheme Scheme	**Credit Scheme**	**Examination**
Lectures: 2 hours / week	Practical: 01	Oral: 50 Marks

Assignments will be given on following point on each unit and industrial visit to any advanced manufacturing industry

1. NC/CNC/DNC Machining, G and M code programming, Turning and vertical machining centers
2. Principle, working and applications of AJM, USM
3. Principle, working and applications of EDM, ECM, LBM, EBM.
4. Assignment on Advance casting process.
5. Assignment of advance welding process.
6. Modeling and Simulation of Manufacturing Processes (at least one simulation assignment on each Unit)

Mechatronics Lab

311111(B)-III

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Practical: 01	Oral: 50 Marks

Lab Work (any 6 of the following)

1. System for measurement of Temperature
2. System for measurement of Force using Strain Gauges
3. System for measurement of Angular Velocity using proximity pickup/ encoders
4. System for measurement of Displacement using LVDT
5. PLC based Hydraulic/pneumatic circuit design
6. Demonstration of Op-Amps for Summing and Inverting Amplifier
7. PLC program for any real time example e.g. elevator, conveyor, bottle filling plant

Materials Management Lab

311111(B)-IV

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Practical: 01	Oral : 50 Marks

Objectives:

1. To develop skills in the subject
2. Application of the theory
3. Understanding of fundamentals of the subject

List of Assignments: [any 8 of the following]

1. Assignment on Costs of Inventories
2. Assignment on EOQ with Practical Constraints
3. Assignment on Replenishment Systems – Deterministic Model
4. Assignment on Replenishment Systems – Probabilistic Model
5. Assignment on Selective Inventory Control
6. Assignment on Disposal of Surplus and Obsolescent stocks
7. Documentation in Materials Management
8. Case – Purchase Management
9. Case – Vendor Selection, Vendor Rating
10. Case – Warehouse Layout Planning
11. Comprehensive Case on Warehousing
12. Study of Inbound & Outbound Logistics Channels of any Industry

Fabrication Lab

311112

Teaching Scheme	Credit Scheme	Examination Scheme
Practical:2 hours / week	Practical:01	TW: 25 Marks

Each candidate shall be required to complete and submit the following term work.

1. Any one job on CNC turning centre/CNC milling centre/vertical machining centre
2. Design and fabrication of any one part using arc welding process
3. Any one job using 3D Printing
4. Mini project based on design and development of prototypes of working machines, mechanisms, robots, production tools etc.

Internship

311113

Teaching Scheme	Credit Scheme	Examination Scheme
Internship: 4 hours / week	Internship:04	TW: 100 Marks

Course Outcomes:

On completion of the internship, learner will be able to –

CO1: To develop professional competence through industry internship.

CO2: To apply academic knowledge in a personal and professional environment

CO3: To build the professional network and expose students to future employees.

CO4: Apply professional and societal ethics in their day to day life.

CO5: To become a responsible professional having social, economic and administrative considerations.

CO6: To make own career goals and personal aspirations.

Guidelines:

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales. Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations. Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

Duration:

Internship to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

Internship work Identification:

Student may choose to undergo Internship at Industry/Govt./NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry [1].

Contacting various companies for Internship and Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination. Student can take internship work in the form of Online/onsite work from any of the following but not limited to:

- Working for consultancy/ research project,
- Participation at Events (Technical / Business)/in innovation related completions like Hackathon,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /

- Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,
- Development of new product/ Business Plan/ registration of start-up,
- Participation in IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos,
- Industry / Government Organization Internship,
- Internship through Internshala,
- In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship,
- Research internship under professors, IISC, IIT's, Research organizations,
- NGOs or Social Internships, rural internship,
- Participate in open source development.

[1] https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in charge of the section where the student has been working.

Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. Internship Diary/workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries
- Adequacy & quality of information recorded
- Data recorded
- Thought process and recording techniques used
- Organization of the information

Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.

Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks + Internship Diary/Workbook and Internship Report - 50 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- Depth of knowledge and skills Communication & Presentation Skills
- Team Work
- Creativity

- Planning & Organizational skills
- Adaptability
- Analytical Skills
- Attitude & Behavior at work
- Societal Understanding
- Ethics
- Regularity and punctuality
- Attendance record
- Log book
- Student's Feedback from External Internship Supervisor

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the student's presence physically, if the student is found absent without prior intimation to the department/institute/concern authority/T & P Cell, entire training can be cancelled.

The report shall be presented covering following recommended fields but not limited to,

- Title/Cover Page • Internship completion certificate
- Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observations
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- Acknowledgement
- List of reference (Library books, magazines and other sources)

Feedback from internship supervisor (External and Internal)

Post internship, faculty coordinator should collect feedback about student with following recommended parameters

Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership…..

Audit Course 6:
Technical writing and communication skill
311114

This course is intended to equip the students with skills to write technical reports and also to equip them with skills to communicate and articulate in English (verbal as well as writing)

Technical Writing –

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills –

- Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors);
- Concord;
- Collocation; Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview;
- presentation of scientific papers

Mandatory Audit Course 6:

Energy Auditing and Management in Industries

311114

Course outcomes:

- Understand the basic concepts of energy audit and energy management
- Explain different types of energy audit, maximizing and optimizing system efficiency.
- Summarize energy management systems, prepare and present energy audit report
- Identify energy saving potential of thermal and electrical systems
- Discuss Energy audit instruments, Procedures and Techniques.

Energy Auditing: Concepts, Need of Energy audit, Types of energy audit, Energy management (audit) approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Energy audit instruments, Procedures and Techniques.

Energy Management: Design of Energy Management Programmes, Development of energy management systems, Importance, Industrial need of Energy Management, Preparation and presentation of energy audit reports, Monitoring and targeting, some case study and potential energy savings.

Text Books:

1. Murphy, W. R., Energy Management, Elsevier, 2007.
2. Smith, C. B., Energy Management Principles, Pergamum, 2007
3. Handbook of Energy Audit, Sonal Desai, Mcgraw Hill Education Private Ltd.,

Reference Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. W.C. Turner, Energy Management Handbook, John Wiley and Sons.
4. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publication, Washington, 1988
5. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982