Syllabus

Savitribai Phule Pune University

Faculty of Engineering

Third Year Production Engineering

(Course 2015)

(with effect from June 2017)

Savitribai Phule Pune University, Pune
Syllabus for Third Year Production Engineering
(2015 Course)
(With effect from Academic Year 2017-18)

Semester- I

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
311081	Metrology &Quality Assurance	3			30	70				100	3	
311082	Industrial Engineering and Management	3			30	70				100	3	
311083	Material Forming	4			30	70				100	4	
311084	Kinematics of Manufacturing Machines	4			30	70				100	4	
311085	Cutting Tool Engineering	4			30	70				100	4	
311086	Production Practice/Employable Skill Development Lab		2						50	50		1
311087	Metrology & Quality Assurance Lab		2						50	50		1
311088	Material Forming Lab		2					50		50		1
311089	Kinematics of Manufacturing Machine Lab		2				50			50		1
311090	Skill Development/ Cutting Tool Engineering Lab		2				50			50		1
											18	**5**
	Total	**18**	**10**		**150**	**350**	**100**	**50**	**100**	**750**	**23**	

Abbreviations:

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

Semester- II

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Seminar	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
311091	Production Management	3			30	70				100	3	
311092	Numerical Techniques & Optimization Methods	4			30	70				100	4	
311093	Machine Tool Engineering	4			30	70				100	4	
311094	Tool Design	4			30	70				100	4	
311095	Process Planning and Tool Selection	3			30	70				100	3	
311096	Seminar and Technical Communication Lab			1				50		50		1
311097	Numerical Techniques & Optimization Methods Lab		2						50	50		1
311098	Machine Tool Engineering lab		2				50			50		1
311099	Process Planning andTool Selection Lab		2				50			50		1
311100	Tool Design Lab		2					50		50		1
											18	**5**
Total		**18**	**8**	**1**	**150**	**350**	**100**	**100**	**50**	**750**	**23**	

Abbreviations:

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

311081: Metrology and Quality Assurance

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

Prerequisites:

- Basic knowledge of Engineering drawing, Machine drawing, Dimensioning and tolerances, various geometrical features.
- Various manufacturing processes and their capabilities, correlation between operating parameters and process responses.
- Basic knowledge of standard machine tools such as: Lathe, Drilling machine, Milling Machine, etc.
- Basic knowledge of standard machine components such as: Gear, spring, Screw threads etc.

Course objectives:

To impart students knowledge of theoretical and practical aspects of measurement standards, measuring instruments and their construction, working and applications. This subject also exposes the students to the principles of measurement, gauges and concepts of quality assurance and their practical use.

Outcomes:
After learning this subject, the student will:

- be able to describe and work with various linear and angular measuring devices
- beable to design limit gauges and work with special measuring devices for gear, screw thread and surface finish measurements
- beable to distinguish various comparators and use profile projector
- beable to use various control charts and various quality assurance tools
- get knowledge of various quality standards and their implementations in industries.
- be able to implement TQM and TPM concepts in practice

Unit I **(8)**

Introduction: Meaning of Metrology, Precision, Accuracy, Errors in Measurement,Calibration.
Linear Measurement: Standards, Classification of Standards, Precision and Non Precision Measuring instrument, Slip Gauges. Manufacturing of slip gauges
Angular Measurement: Sine bar, Sine Center, Uses of sine bars, angle gauges, Auto Collimator Angle Dekkor.
Inspection of Geometric parameters: Straightness, flatness, Parallelism, Concentricity, Squareness and Circularity. Alignment testing- lathe/milling/ drilling m/c
Comparators: Uses, Types, Advantages and Disadvantages of various Comparators.

Unit II **(8)**

Limits, Fits and Tolerances: Meaning of Limit, Fits and Tolerance, Cost -Tolerance relationship, concept of Interchangeability, selective assembly, Indian Standard System. Design of limits
Gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges, Introduction to auto gauging systems.
Interferometry: Introduction, Flatness testing by interferometry, NPL Interferometer.

Unit III (8)

Surface Finish Measurement: Surface Texture, methods of evaluation of surface roughness, Grades of Roughness, Specifications, Tomlinson's Surface Recorder, Taylor- Hobson Surface Meter and Talysurf for measuring all characteristics of surface texture.

Screw Thread Metrology: External Screw Thread terminology, effective diameter measurement methods, Pitch and flank Measurement of External Screw Thread, Application of Tool Maker's Microscope, Use of Profile Projector.
Gear Metrology: Spur Gear Parameters, Gear tooth thickness measurement: Gear tooth Vernier caliper, Constant chord method, Span Micrometer, Base tangent method.

Recent Trends in Engineering Metrology-Universal measuring machine coordinate measuring machine, laser interferometer.

Unit IV (8)

Introduction to Quality

Meaning of Quality, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, Role of Quality in Present day environment. Introduction to Statistical Quality Control: Control Charts, X, R, P and C Charts, Sampling inspection, OC Curves and Sampling Plans, Process Capability Index (PCI), Concept, Methods of determining PCI and uses of PCI.

Unit V (8)

Quality Assurance tools and techniques

Total quality management (T.Q.M):- Approaches-Deming's Approach,Juran's Approach, , Seven quality tools and new seven quality toolsQ.F.D., Quality Circles, Kaizen, six sigma, T.P.M. Technical Specification (T.S) TS 16949 Standards.

Unit VI (8)

Quality Standards

ISO 9001-2000 Series of Standards- History and Evolution ofISO 9000Series, 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, benefit of Environmental Management Systems, Environmental, Health and Safety standards.

Text Books:

1. K.J.Hume, "Engineering Metrology", Kalyani publi cation ISBN8170290015
2. K.W.B.Sharp, "Practical Engineering Metrology", Pitman Publication
3. F. M. Gryna, R. Chua & J. Defco, "Jurans Quality Planning and Analysis for Enterprise Quality", McGraw Hill series. ISBN0070618488

ReferenceBooks:

1. R.K. Jain, "Engineering Metrology", Khanna Publication.
2. I.C.Gupta, "A Text book of Engineering Metrology", Dhanpat Rai and Sons.
3. Kaoru Ishikawa, "Guide to Quality Control", Asian Productivity Organisation, Series,
4. Juran's Quality Handbook

311082: Industrial Engineering and Management

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

Prerequisites:
knowledge of machines used in manufacturing organizations.

Course objectives:
1. To understand and apply management principles in to manufacturing organization.
2. To understand concepts of work study, method study, and time study to improve productivity of any manufacturing organization.

Outcomes:
1. Summarize the contribution of peoples to management.
2. Differentiate between two employees on the basis of productivity.
3. Prepare time schedule to complete the task.

Unit I **(7)**

Evolution of Management Practices: Characteristics, objectives Functions, Principles and Types of Management., Scientific Management-Contribution of F. W. Taylor, Henry Fayol Gantt, Maynard and Indian contributors to the Management thought.

Organization: Definition, Principles, Function and Types of organization structure, Different forms of Business—Proprietor, Partnership Firm, Private & Public limited company, Cooperative, Private &Public Trusts.

Unit II **(7)**

Motivation: Human Needs and Types of Motivation, Theories of Motivations-Maslow's theory, McGregor's Theory of X and Theory of Y, Herzberg's Theory of two factor, David C.McCelland's Theory of Achievement, Expectance/valence Theory of Victor Vroom, Porter & Lawler's Model. Group dynamics: Types, characteristics, objectives of Group Dynamics Leadership: Definition, styles & functions of leadership, qualities for good leadership, role of the leader, Theories of leadership, Managerial grid, professional and business ethics.

Unit III **(7)**

Entrepreneurship development: Characteristics of successful entrepreneurs, communications skill, problem solving skill and process, Basic element of Business plans, Sources of finance, Selection of Business location, Record keeping system, Analysis financial performance, Break even analysis, Technology and Business, Strategies for Business Growth, Concept related to start-up and Intellectual Property Rights (IPR).

Unit IV **(8)**

Industrial Engineering: History, Development, Definition, Functions & Applications of Industrial Engineering. Tools and techniques of Industrial Engineering, Introduction to work study and work content.

Productivity Engineering

Productivity: factor productivity, total productivity; labour Productivity, measurement of Productivity, Productivity improvement techniques. Productivity improvement programme.

Wages and incentives: Concept of wages, factors affecting wages, Job evaluation, merit rating.

Unit V **(8)**

Method Study

Steps, Tools and Techniques used in the Method Study, outline Process Chart, Flow process Chart, Symbols, Flow Diagrams, Two Handed Chart, String diagram, Multiple Activity Chart, 5W and 1 H,Use of Motion Pictures and its analysis SIMO chart, cyclegraph Chronocylegraph. Developing, Presentation, Installation & Maintenance of new Methods. Principles of motion economy.

Unit VI **(8)**

Work Measurement

Time Study: Aim & Objectives, Terminology & Tools, Use of stopwatch procedure in making Time Study. Time Study Forms, Performance rating, allowances and its types. Calculation of Standard Time.

Work Sampling: Introduction to work sampling. Determinations of Standard time using work Sampling.

Synthetic & Standard data Methods: Concepts, Introduction to PMTS, MTM1, WFS, and Basic Motion Time Study. MTM2 & Other second Generation Methods, MOST and other advanced work measurement techniques.

Text Books:

1. M. Telsang, “Industrial Engineering and Production Management”, S. Chand Publication, ISBN 81 219 1773 5.
2. O. P. Khanna, “Work Study”, Dhanpat Rai Publications, New Delhi.
3. Banga & Sharma, “Industrial Organisation & Engg. Economics”, Khanna Publishers, 2001, ISBN 81-7409-078-9
4. Chabra T. N., “Principles & Practices of Management”, Dhanpat lal & compony.
5. Mahajan M., “Industrial Engineering and Production Management” Dhanpat Rai and Sons Publishers, 2005, ISBN-81-7700-047-0

Reference Books:

1. H. B. Maynard and others, “Industrial Engineering Handbook”, IVth edition McGraw Hill Publications, ISBN 0-07-041084-4.
2. “Introduction to Work Study”, ILO Universal Pub. Co,B’bay,ISBN 81 85027 06
3. Ralph M. Barnes, “Motion and Time Study: Design and Measurement of Work” J. Wiley & Sons.
4. Koontz Harold and Weihrich Heinz, “Essentials of management”, 7ed, Tata McGraw Hill publishing, 2008, ISBN 0-07-0623030-x.
5. Luthans f., “Organizational Behaviour”, McGraw-Hill Company, 2008, ISBN 81-317-0502
6. Cynthia L. Greene, “Entrepreneurship: Ideas in Action”, Thomson, ISBN-981-243-257-1.

311083 : Material Forming

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

Material forming is a manufacturing process in which the shape of metal work piece is changed by plastic deformation of the metal. Theory of plasticity (yield criteria) deals with the mechanism of plastic deformation. Material forming processes classified on the basis of forces applied to the work piece and the working temperature (hot/cold/warm).The subject deals with various forming processes such as forging, wire/rod/tube drawing, rolling, extrusion along with special advanced forming processes.

Pre-requisites: Physics, Engineering Metallurgy, Strength of material

Course objectives:
1.To analyze the forming processes.
2.To identify, evaluate and overcome forming problems and defects
3.To analyze and identify applications of special forming processes

Course outcomes:
1.Students will understand mechanism of plastic deformation.
2.Students will classify and analyze various forming as well as special forming processes
3.Students will identify problems (defects) in forming processes and apply knowledge to overcomethese problems**.**

Unit I **(8)**

Fundamentals of Material Forming

Introduction of forming processes. Concept of plastic deformation Classification of material forming process, True stress-True strain, Strain hardening, flow stress determination, Theory of plasticity, Yield criteria for ductile materials: Von-mises criteria, Tresca criteria. Effect of temperature, strain rate, friction, metallurgical microstructure. Concept of Formability, formability limits and formability diagram.

Unit II **(10)**

Forging

Introduction, Classification of forging processes. Forging equipment- Hammers, presses, Upstter etc., construction, working, capacities and selection of equipment. Basic forging operations such as fullering, edging, drawing, blocking,finishing etc., Types of forging dies, Forgeability tests, design of forging as a product, friction in forging. Cleaning and finishing of forgings, Forging defects and the remedies. Analysis of forging with sliding and sticking friction, New technologies: Liquid metal forging, isothermal forging, No draft forging, P/M forging, Rotary swaging, roll forging, Lubrications in forging.

Unit III **(08)**

Wire, Rod and Tube Drawing

Introduction to rod and wire drawing machines - construction and working. Preparation of stock for wire drawing. Wire drawing dies, material and design. Analysis of wire drawing operation, Variables in wire drawing, Maximum reduction in wire in one pass, forces required in drawing. Multiple drawing, work hardening, lubrication in wire drawing, strip drawing.
Tube Drawing: Methods, force calculation, stock preparation. lubrication in tube drawing.

Unit IV **(08)**

Rolling of Metals

Scope and importance of rolling. Types of Rolling Mills **-** Constructionand working. Roll bite,

reduction, elongation and spread. Deformation in rolling and determination forces required. Process variables, redundant deformation. Roll flattening, Roll cambering, Mill spring – its effect on rolling process. Defects in rolling. Automatic gauge control(AGC), Roll pass classification & design. Lubrication in rolling.

Unit V **(08)**

Extrusion

Types: Direct, Indirect, impact, hydrostatic extrusion. Dies for extrusion, stock preparation. Extrusion ratio, Circumscribing circle diameter (CCD), Shape factor. Equipment (with and without friction), Work done in extrusion, Metal flow in extrusion, defects. Role of friction and lubricants. Manufacture of seam-less tubes.

Unit VI **(10)**

Advances in Metal Forming

High Energy Rate Forming process (HERF), High Velocity Forming(HVF) - Principles, comparison with conventional forming processes. Explosive forming, Magnetic pulse forming, Electro hydraulic Forming. Petro-forge forming , Micro forming, Micro coining, micro extrusion, Micro bending, Stretch forming, coining embossing, curling spinning, flow forming advantages, limitations and application of the process, methods of measuring friction in metal forming.

Text Books:

1. Dieter, “Mechanical Metallurgy” ISBN0071004068
2. P.N. Rao, “Manufacturing Technology”, Tata-McGraw Hill ISBN0070087695
3. G.W. Rowe, “Principles of Industrial Metal Working Process”, Edward Arnold ISBN8123904282.
4. Juneja B. L., “Fundamentals of metal forming processes”, New Age International Ltd.

Reference Books:

1. Dr. R. Narayanswamy, Metal Forming Technology, Ahuja Book Co., ISBN8176190020
2. Surender Kumar, Principles of Metal Working.
3. ASM: Metal Handbook, Volume 14, “Forming”.
4. SME:Tool and Manufacturing Engineers Handbook, Volume 2, “Forming”

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311084 : Kinematics of Manufacturing Machines

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Engineering Mechanics, Mechanics of Materials, Theory of Machines, Design of Machine Elements.

Course objectives:
1. To impart students with the knowledge about kinematic synthesis, analysis of mechanisms.
2. To enable students to apply fundamental of kinematics to machines this includes kinematics of gears, gear trains, cams etc.
3. To facilitate students to understand the function of flywheels, the concept of balancing of rotating and reciprocating masses
4. To give awareness to students on the phenomenon of vibration and its effects

Outcomes:
After studying the subjects students will be able to
1. Perform kinematic synthesis, analysis of mechanisms.
2. Apply fundamentals of kinematics of machines this includes analysis of kinematics of gears, gear trains, cams etc.
3. Analyze kinematics of flywheels, the balancing of rotating and reciprocating masses
4. Evaluate effect of vibration and remedial actions.

Unit I **(8)**
Synthesis and Analysis of mechanisms
Computer Aided Analysis and coupler curves for four bar mechanism and slider crank mechanism, dimensional synthesis of mechanisms, three position synthesis of slider crank mechanism, Over lay method, Bloch Synthesis, Least square technique.

Unit II **(8)**
Theory of gears: Spur, bevel, worm gears
Involute and cycloid profile, path and arc of contact, interference and undercutting. Terminology of Bevel Gears, Worm and worm wheel: design approach of equivalent teeth for bevel gears, geometrical relationships, tooth forces, torque transmitted.

Unit III **(8)**
Gear Trains
Simple, compoud, epicyclic gear trains, differentials, Computation of velocity ratios and torque transmitted in epicyclic gear trains

Unit IV **(8)**
Cams and flywheels

Cams: Types of cams and followers, terms used in radial cams, analysis of motion of follower, displacement, velocity, acceleration, and jerk diagrams, and determination of cam profile for various types of follower motions: uniform velocity, SHM, uniform acceleration and retardation,

Flywheels: Introduction, Turning Moment Diagram ,Fluctuation of speed, Fluctuation of energy, Coefficient of fluctuation of speed, Maximum fluctuation of energy, Energy stored in flywheel, flywheel in engines & punching presses.

Unit V **(8)**

Balancing

Need for balancing, Static balance, balancing of rotating masses in same and different planes, Dynamic balancing, balancing of reciprocating masses, Balancing of locomotives, Partial balancing of locomotives, swaying couple, hammer blow, variation in tractive effort,

Unit VI **(8)**

Mechanical Vibrations

Introduction, Degree of freedom, Types of vibrations, Damped vibrations; under damped, critically damped and over damped systems, response curves for single degree of freedom system. Rotating and reciprocating unbalance, base excitations, Vibration Isolation and transmissibility; Force transmissibility, Motion transmissibility. Forced vibration with rotating and reciprocating Unbalance. Materials used in vibration isolation, Longitudinal and Transverse Vibrations, whirling of shaft Vibration measuring instruments.

Text Books

1. S.S.Ratan , “Theory of Machines”, Tata McGraw Hill [ISBN0070591202]
2. R.S.Khurmi, J.K.Gupta, “Theory of Machine”, S Chand Co. Delhi. [ISBN812192524X]
3. P.L.Ballaney, “Theory of Machine”, Khanna Publisher.
4. G.C. Sen & A. Bhattacharya, “Principles of Machine Tools” [ISBN8173811555]

Reference books

1. J. E. Shigley and J.J.Uicker Jr., “Theory of Machines and Mechanism”, McGraw Hill [ISBN019515598X]
2. G K Grover’, “Mechanical Vibration”, Nemchand and brothers. [ISBN8185240752]
3. S. Graham Kelly, Schaum's Outline of Mechanical Vibrations, McGraw Hill Professional, 1996, [ISBN: 0070340412]

311085 : Cutting Tool Engineering

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Machine Drawing & Computer Graphics, Machine Tool Operations.

Courseobjectives:
1. To demonstrate effect of cutting tool geometry on economics of machining
2. To demonstrate design process of cutting tool
3.To present theory and design aspects of jigs and fixtures

Outcomes:
Students will be able to:
1. Understand the different cutting tool geometry and economics of machining
2. Calculate the cutting force components in orthogonal cutting
3. Understand, design and draw the different cutting tools
4. Understand the different principles of locating and clamping
5. Understand, design and draw the Jigs and fixtures and to understand environmental issues, decide manufacturing policies, various responsibilities of engineering professional etc.

Unit I **(8)**
Theory of Metal Cutting
Geometry of single point tool, Concept of speed, feed, depth of cut, Effect of cutting parameters on tool geometry, Chip formation, Types of Chips, Orthogonal & oblique cutting, Determination of shear plane angle, Cutting force components in orthogonal, Merchant model for orthogonal cutting, Ernst Merchants theory, Chip velocity, Strain in chip, Estimation of cutting forces and cutting power.

Unit II **(8)**
Cutting tool standards, Materials & Cutting force measurement
Tool angle specification systems, British system, American system, German system,ISO system . Cutting tool materials, Desirable properties of tool material, Coating tools, Coating techniques on tool, Heat treatment of tools.
Classification of dynamometers , Study of working principles in Lathe ,Milling ,Drilling, Grinding dynamometers.
Nonconventional tool geometry: Koleshov tool, Antichatter tool, Gustin tool, Throwaway inserts.

Unit III **(8)**
Heat generation, tool life & Economic of cutting tools
Sources of heat generation, Tool wear and its type, Tool wear mechanism, Types of cutting fluids, Selection of cutting fluids.
Tool life equation of Taylor. Factors affecting tool life, Tool failure criteria.Machinability and its rating, Machinability criteria, Economics of machining. Criteria for minimum cost & maximum production.

Unit IV **(8)**
Design of cutting tools
Chip breakers, Throwaway inserts and methods mounting, Design of single point cutting tool, Design of circular & tangential form tools, drill, reamer, milling cutter and broach. Manufacturing of Cutting tools

Unit V **(8)**

Fundamentals of Jigs and Fixtures

Six degrees of freedom, Six point location principle 3-2-1, , Types of locators, Redundant location, Types of clamping devices , Types of drill bushes, Types of support pins, Fool proofing, Classifications of jigs and fixtures. Indexing mechanisms.

Unit VI **(8)**

Design of Jigs & Fixtures

General guidelines & procedures for design of Jigs and fixtures, Economics of Jigs and fixtures, Pneumatics & Hydraulics for jig & fixtures.Concept of modular fixtures & tool presetting fixtures

Text Books:

1. Wilson, “Fundamentals of tool design”, A.S.T.M.E .
2. M.H.A. Kempster, “Introduction to Jigs and fixtures design”.ISBN8185617856.
3. 3.Dr.B.J.Runganath’”Metal Cutting and Tool Design”,Vikas Publication,ISBN0706975103
4. G. Kuppuswamy, “Principles of Metal Cutting”,University press, ISBN 81 73710287.
5. Basu, Mukherjee and Mishra, “Fundamentals of Tool Engineering and Design”,
6. Oxford publishing. ISBN812040016X.

Reference Books:

1. P C Sharma, “Production Engg”. , Khanna publishers. ISBN8121904218.
2. P.C. Sharma, “Machine tools & Tool Design”. Khanna publishers, ISBN812192362X.
3. Surender Kumar, “Production Engineering Design”,Sataya Publication
4. Dolalson, Lecain and Goold, “Tool design”, Tata McGrawhill.ISBN0070992746.
5. Hoffman, “Introduction to Jigs and fixtures”.Delnar Cengage Leraning Publication
6. “Tool Engineering Handbook”, A.S.T.M.E.
7. R. K. Jain, “Production Technology”, Khanna Publishers.ISBN8174090991
8. Milton Shaw, “Metal cutting principle”CBS Publication.
9. P .H. Joshi, “Jigs & Fixtures”. Wheeler Publication ISBN074601695.

311086 : Production Practice/Employable Skill Development Lab

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

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

A 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.
3. **CNC Job**: Demonstration / job on CNC machine. It should consist of step turning, taper turning, and fillet (Radial) & chamfering.

Part B: - **Journal consisting of:**

1. 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

3.CNC programming for
a)Lathe job
b)Milling job

Note: - A practical examination of 12 hours duration shall be conducted.

311087 : Metrology and Quality Assurance Lab

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

A] Experiments: (Any Eight)

1. Linear Measurement using precision instruments.
2. Measurement of angle by sine bar / Sine center
3. Alignment Test on Lathe/ Drilling/Milling Machine.
4. Measurement of the Surface roughness
5. Measurement of Optical surface using Interferometer.
6. Measurement of Screw thread parameters using Floating Carriage Micrometer.
7. Measurement of Gear tooth thickness using Gear tooth Vernier caliper or Span micrometer
8. Study and Experiment on Profile Projector.
9. Study and Experiment on any type Comparator.
10. Study of Limit Gauges and auto gauging systems.

B] Reports based on Industrial Visit

311088 : Material Forming Lab

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

Term work;
Term work shall consist of:
1. Assignment based on each topic of syllabus
2. Industrial visit and report based on visit

311089 : Kinematics of Manufacturing Machines Lab

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

Term Work
Term work will be based on following practical/design assignments
1. To write a computer program for analysis and animation of any mechanism and test it.
2. To draw a conjugate profile for any general shape of gear tooth.
3. Determination of holding torque in epicyclic gear train.
4. To draw a cam profile for specific follower motion
5. Study of flywheel.
6. Experiment on balancing of mass.
7. Experiment on free undamped and free damped vibration of single degree of freedom system

311090 : Skill Development - Cutting Tool Engineering Lab

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

List of Experiments:
1. Experiments on chip formation.
2. Verification of Metal cutting Theories.
3. Measurement of cutting forces (anyone) in Turning / Milling / Drilling.
4. Effect of tool geometry, cutting speed, feed, depth of cut on cutting parameters.
5. Design and working drawing of any three of following cutting tools: Single point tools, Form tool, Reamer, Milling cutter, Broaches and Drills.
7. Design and Working drawing of one jig. (Drilling, Reaming, Tapping)
8. Design and Working drawing of one fixture. (Turning, Milling, Broaching)

311091 : Production Management

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

Prerequisites:
Industrial Engineering & Management.

Courseobjectives:
1. Introduce concepts of productivity and efficiency of manufacturing organization.
2. Demonstrate concepts of production management such as production planning and control, facility planning, capacity planning, and scheduling
3. Apply the concept of deterministic inventory models

Outcomes:
Upon successful completion of this course, students will learn to:
- Demonstrate awareness and an appreciation of the importance and strategies for the Production and operations management to the sustainability of an enterprise.
- Demonstrate a basic understanding of Production Systems and Production Planning and Control.
- Demonstrate an awareness of the importance of facility layouts and implement in their In-Plant training project work.
- Demonstrate an understanding of the principles of just-in-time systems.
- Explain the importance of forecasting and demonstrate the ability to apply some mathematical forecasting techniques.
- Demonstrate an understanding of the concept of operations scheduling.
- Demonstrate an understanding of the problems involved in inventory management.

Unit I **(8)**
Scope of Production Management
Scope of production/operation management, relationship with other functions, history of operation management, types of production system-operation and organization, Operation strategies: competing on cost, quality, flexibility, speed, productivity, efficiency & effectiveness.

Unit II **(7)**
Production Planning &Control
Need for production planning & control, preplanning functions, product design & development, product life cycle, new product development process, marketing aspects, product characteristics, production aspects, economic aspects, cross functional product design, concurrent engineering, design for manufacturing, FMECA, QFD.

Unit III **(7)**
Facility Planning
Facility location, important factors affecting location decision, location theories, basic types of layouts, layout planning & designing, hybrid layouts, dynamic layout, computerized layout planning, design of operation line, line balancing, Maintenance planning, Total Productive Maintenance.

Unit IV **(7)**
Capacity Planning
Importance of forecasting, long term & short term forecasting techniques, forecasting errors,

method of planning, routing & estimating, capacity planning-strategies, analysis of machine capacity, aggregate capacity planning & manpower planning. Introduction to Supply chain management, Just in time & Lean manufacturing.

Unit V **(7)**

Loading & Scheduling

Concept of loading & scheduling, master production schedule, basic sequencing & scheduling techniques-Johnson method, critical ratio scheduling, uses of CPM & PERT, RAMPS (Resource Allocation & Manpower Scheduling), dispatching rules, expediting & evaluating the production plans, design of production planning & control system for intermittent & continuous production. Computerized production management system

Unit VI **(7)**

Inventory Theory

Introduction, Meaning of Inventory Control, Functional classifications of Inventories, advantages of Inventory Control. Costs associated with Inventories, selective control of inventories, Deterministic Inventory Models: economic lot size with instantaneous replenishment with and without shortage costs, economic lot size with finitereplenishment with and without shortage, economic lot size models with quantity discount. Economic manufacturing quantity (EMQ), fixed order quantity and fixed order interval system.

Text Books:

1. Paneerselvam R., “Production and Operations Management”, Prentice Hall India 2012, 3rd Edition ISBN9788120345553
2. Chary S. N., “Production and operations management”, Mc Graw Hill Education 5th Edition, ISBN9781259005107
3. Riggs. J. L., “Production system, planning, analysis and control”, John Weily and sons, New York.ISBN0471858889.
4. James Dilworth, “Production and operation management”, McGraw Hill Book Company, New York. ISBN 9780070169876
5. Martand Telsang, “Industrial Engineering and Production Management”, S Chand & Co, New Delhi.ISBN8121917735
6. 6.Prasanna Chandra, “Project Planning Analysis Selection Implementation and Review”.ISBN0074620495.

Reference Books:

1. Buffa. E.S., “Modern Production and Operation Management”, Willey, New Delhi. ISBN9971511630.
2. Adam EE & RJ Ebert, “Production and operation management:, Prentice Hall Englewood Cliff, N.J. ISBN8120308387.
3. Garg A. K., “Production and operations management”, Mc Graw Hill Education 1st Edition, ISBN9781259005107
4. Samuel Eilon, “Production planning and control”. Universal Publishing Corporation ISBN8185027099.
5. Joseph Monks, “Operation Management Theory and Problems”, McGraw Hill Book Company, New York.(1991), ISBN007100579X.
6. F. L. Francis, J. A. White, L. F. McGinnis, “Facilities Layout and Location”, Prentice Hall of India Pvt. Ltd., ISBN 81-203-1460-3. 8120314603.
7. Richard Muther, “Systematic Layout Planning, Van Nostrand Reinhold; 2nd edition ISBN978-0933684065

311092 : Numerical Techniques and Optimization Methods

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

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

Course objectives:
1. To demonstrate potential of numerical methods for solving complex algebraic & transcendental equation, simultaneous equations, curve fitting, interpolation, optimization, integration & differentiation.
2. To present the applications of computational tools & techniques to the real life case studies in production engineering
3. To develop ability of student to formulate an optimization model and apply appropriate method of optimization to solve production engineering problems
4. Facilitate concept of database design query process optimization & normalization.

Outcomes:
After studying the subjects students will be able to
1. Apply numerical methods to production engineering problems
2. Develop mathematical model of physical problem and subsequent solution by appropriate optimization method
3. Design the database using ER model & work with relational algebra & relation calculus and to manage & control concurrent transactions using query process optimization & normalization.

Unit I (8)

Numerical Method - I

Revision of „C_ syntax/ Matlab. 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 II (7)

Numerical methods -II

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 III

Numerical methods -III

Ordinary Differential Equations.- Runge-Kutta Method. Partial Differential Equations -Finite difference method
Numerical Integration: The Trapezoidal Rule, Simpson's Rules, Romberg Integration

Unit IV (7)

Numerical methods -IV

Manufacturing Optimization- Method of Lagrange multipliers, steepest descent method,

Generalized reduced gradient Method. Introduction to GA and SA.

Unit V **(8)**

Design and Analysis of Experiments:
Important 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 VI **(7)**

Database Management and SQL
Introduction, Organization & component of database management system (DBMS), data models, entity relationship model, advantages & disadvantages in database processing, hierarchical & network databases. Database design- dependencies and normalization (1rst & 2nd order), database storage and querying, aggregate functions. – Group by, having order by, sub-queries and various SQL operators.

Introduction to oracle, SQL, Database creation, database retrieval, use of compound conditions like AND, OR, Joining and updating tables.

Text Books:

1. Silberschatz, Korth H F, Sudarshan, “Database System Concepts”, McGraw Hill Intl., 4th Edition, 2002, ISBN 0071005293.
2. A.M. Muzumdar and P. Bhattacharya, “Database management System”, Tata McGraw Hill Publication, New Delhi, ISBN 0074622390.
3. Turban, Rainer & Potter-John, “Introduction to Information Technology”, Wiley & Sons, 2000, ISBN 8126509686.
4. Ivan Bayross, “SQL. PL/SQL – The programming language of oracle” BPB publication, New Delhi, ISBN 81-7656-964-X.

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Reference Books:

1. Rajashekhar Sundarraman, “Oracle91 Programming: Primer”, A Pearson Education, 2004, ISBN 8129703629.
2. Dr. Sadhu Singh, “Computer aided Design and Manufacturing”, Khanna Publication, New Delhi.
3. Y. Kanetkar, “Let Us C”, BPB Publications, 4th revised edition 2002, ISBN 8176566217.
4. B.S. Gottfried, “Programming with C”, McGraw Hill Intl., Schaum‟s Outline Series, ISBN 00071006214.
5. S.C. Chapra, R.P. Canale, “Numerical Methods for engineers with programming and software applications”, Tata McGraw Hill Co. Ltd, New Delhi, ISBN 0071158952.

311093 : Machine Tool Engineering

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

Prerequisites:
Students should have basic knowledge of conventional manufacturing processes and machine tools like center lathe, theory of machines and mechanisms, machine drawing, and process planning.

Course objectives:
(i) To demonstrate evolution in the field of machine tools and their automation, Pros and cons of hard automation.
(ii) To introduce operational issues of NC/CNC/DNC machines and automated material handling systems
(iii) To present process mechanism and analysis of advanced manufacturing processes
(iv) To provide practical knowledge of Control, Maintenance, Reliability & Installation of machine Tool

Outcomes:
Students will be able to:
(i) Classify and describe with a neat sketch the construction and working of various automats
(ii) Compare and contrast NC/CNC and conventional machine tools
(iii) Explain the objectives, principles and selection criteria of Material Handling Systems
(iv) Classify and describe various material handling equipments
(v) Classify, compare and explain with neat sketches various non- conventional machining processes.
(vi) Describe special processes used for manufacturing of gears and threads with a neat sketch
(vii)Explain meaning, considerations, types, and significance, as applicable, of installation, control, maintenance and reliability of machine tools.

Unit I (8)
Turret and automat machine - Automation Concepts, Automatic and Semiautomatic Machine Tools and their, Classification, Turret and Capstan Lathes. Single Spindle and Multi-spindle Automats, setup of automatics and semi automatics. Tooling Layout and operation Sheet, Cam, Tool Layout for Single spindle automat., Concepts of Transfer Machines/ Lines.

Unit II (8)
NC/CNC/DNC Machines
NC/CNC Machining: Introduction to NC,CNC,DNC Machines, Tape format and basic G and M codes, Comparison between NC and Conventional Machine Tools, Basic Principles of NC Machines, its Advantages, Tooling Requirements, Introduction to Turning and Machining Center, PLC based machine tools

Unit III (8)
Material Handling Systems
Material Handling: Objectives, engineering & economic considerations, principles of material handling, selection & classification of material handling equipments, numerical based on economic consideration, Relation between plant layout and material handling.
Automatic Storage and Retrieval System (ASRS), Automated Guided Vehicles (AGV), Interfacing of Advanced Material Handling Equipment with Manufacturing Equipment,

Unit IV (8)

Non-conventional machining process

Detail study with respect to working principle , process parameter, theoretical analysis, experimental results & comparative assessment of Abrasive jet machining, Ultrasonic machining, Chemical machining, Electrochemical machining, Electro discharge machining, Electron beam machining, laser beam machining, Plasma arc machining, Ion Beam machining, wire cut EDM, Numerical based on above processes

Unit V (8)

Special manufacturing Processes

Different methods of Gear manufacture – Gear hobbing and gear shaping machines - specifications – gear generation – different methods, gear finishing and shaving,
Grinding and lapping of hobs and shaping cutters – gear honing gear broaching.
Thread manufacturing – Review of thread chasing, die Threading& tapps, thread rolling, thread whirling, milling, thread grinding, & thread whirling

Unit VI (8)

Control, Maintenance, Reliability & Installation of machine Tool

Machine Tool Operator's Control Systems: Need of Standardization, Classification, Controls in Conventional and NC/CNC Machines, Adaptive Control.
Machine Tool Installation and Maintenance, installations and maintenance of machine tool ,Introduction to reliability of machine tool, availability and maintainability

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. K.K AHUJA - “Production and Operations Management " , Prentice Hall of India, 1995.
5. Allegri Theodore, “Material Handling Principles and practice” (CBS Publisher Delhi)

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 Internati onal 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. G C Sen. and A.Bhattacharya ,“Principles Of Machine Tools”, New Central Book Agency Pvt Ltd, Calcutta, ISBN 81 7381 155 5.
7. Pandey, Shan; “Modern Machining Processes”.
8. Ghosh Amitabh,A. Malik; “Manufacturing Science”, East-West Press Pvt. LTD,ISBN 8185095 85 X.
9. P.N.Rao, “CAD/CAM/CIM Principles”, Tata McGraw Hill Publication,

311094 : Tool Design

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 30 Marks End-Sem : 70 Marks

Tool design is specialized area of Production Engineering which deals with planning, design, construction of press tool, forging dies and injection molds at minimum overall cost.

Prerequisites: Engineering Graphics, Machine drawing, Material forming

Course objectives:

1. Todemonstratemechanism and analysis of press working, forging, die casting and plastic processing.
2. To present design process of Press tools, forging dies and Injection molds.

Outcomes: Students will be able to-

1.Students will understand various press working operations, plastic processing processes

2. Students will be able to apply knowledge for designing of Press tools, forging dies and Injection molds.

3.Students will be able to draw and construct the assembly of Press tools, forging dies and Injection molds.

Unit I (8)

Introduction of Press working

Press working terminology, Basic operations, types of presses- mechanical, hydraulic, pneumatic and their mechanisms, elements of die sets, types of die sets, types of dies: simple, compound, progressive, combination and inverted dies, types of punches, Methods of reduction of shear force, types of strip layouts, types of strippers, types of pilots, types of stoppers, selection of dowel pins and screws. Design of Blanking die.

Unit II (8)

Design of Progressive, compound and combination dies

Strip layout, percent utilization, Calculation of force, Press capacity, clearances, die and punch size, center of pressure, methods of piloting, Design and drawing of progressive, compound and combination die.

Unit III (8)

Design of Drawing and Bending Dies

Design of shallow and deep drawing die, Calculation of blank size by area and graphical method and standard formula, percentage reduction in each stage , number of draws, drawing force, blank holding force, press capacity, ironing force.

Types of Bending dies, Developed length calculation, bending force, spring back & methods used to overcome it in a press brake.

Die castings dies: Die casting machines-Hot & cold chamber, metals for die casting, die locking methods, interlocks & safety devices, specific details of die constructions, casting ejection, cores, slides, loose die pieces, types of cores, directional solidification, types of feeders, die venting, water cooling, classification of dies- single, combination, multi-impression. General details of die

design, inserted impressions, die casting defects & their remedies, die lubrication- types & methods

Unit IV **(8)**

Design of Forging Dies

Design of forging die for multi-impression die-: selection of parting line, drafts, fillet & comer radii, ribs and webs, stock size calculation, flash and gutter, design of fullering, edging, blocking, finishing impressions, trimming dies, Die block dimensions, die inserts. Rules for upset forging, design of upset die.

Unit V **(8)**

Plastics processing

Compression, transfer, injection, extrusion, blow & rotational moldings Thermoforming. General construction of injection moulds- Interger mold , insert mold , bolster , guide pillar, register ring, types of nozzles splits, side cores & side cavities, molding internal undercuts. Types of ejectors. Types of runners & gates.

Unit VI **(8)**

Design of Injection mould

Determination of number of cavities, design of feed system- design of sprue, sprue puller, runners & gates, types of cooling system, design of cooling channels, heat transfer considerations, , determination of mould opening force & ejection force, design of ejector system, use of CAD for mould design.

Text Books:

1. Donaldson, Lecain and Goold, “Tool Design”, Tata McGraw Hill, ISBN 0 07 0992746.
2. J R Paquin, “Die design Fundamentals”, Industrial Press Inc., ISBN 0 8311 1172 0.
3. Doehler H.H, .”Die Casting”, Mc Graw Hill
4. P.N. Rao, “Manufacturing Technology, Foundry, Forming and Welding ”, Tata McGraw Hill, ISBN 0 07 451863 1.

5.R.G. W. Pye, “Injection Mould Design(Design manual for plastic industry)”, EWP

Reference Books:

1. P.H. Joshi, “Press Tools Design & Construction”, Wheeler Pub., ISBN 81 85814465.
2. P. C. Sharma, “Production Engineering”, S. Chand, ISBN 81 219 0421 8.
3. Dr. Surender Kumar, “Production Engg. Design” (Tool Design), Satya Prakashan
4. A.S. Athalye, “Plastics Materials handbook”, Multitech Pub. Co., ISBN 81 7671 007

311095 : Process Planning and Tool Selection

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

Pre-requisites:
Basic knowledge of CAD, Machine Drawing and Computer Graphics, Manufacturing Process, Cutting Tool Engineering, Production Practice, Industrial Engineering and Management

Course objectives:
1. To provide details of the aspects Process engineering, Product design and role of product designer
2. To demonstrate application of geometric dimensioning and tolerance analysis.
3. To analyze and differentiate between Work-piece control and selection of operations.
4. To analyze factors affecting Selection of Equipment & Tooling.
5. To demonstrate process Selection, capacity Planning and approaches for CAPP

Outcomes:
Students will be able to
1. Carry out Part print analysis of industrial component drawing
2. Design of Process sheet on GPM for batch production
3. Design of Process sheet for mass production
4. Compute time estimation for assembly using flow-charting techniques
5. Analyze and differentiate between Computer aided process planning

Unit I **(8)**

Process Engineering:

Product design and role of product designer

Analysis of part print: Method of reading and interpreting the part print, identification of nature of work to be performed, Identification of functional surfaces, grouping of related surfaces to be machined, Identification of basic process for processing and sequence of operation from part print.

Process engineering and its functions, Co-ordination of process Engineering with other departments., Organization chart, general manufacturing processes, concept of design for manufacturing, communication in engineering Industry, glossary of terms used in process planning.

Unit- II **(8)**

Geometric dimensioning and tolerance analysis

Dimensional Analysis:

Types of dimensions, concept of baseline dimensions, datum selection, dimensional chain and linkage analysis, concept of straightness, flatness, roundness, concentricity and other geometrical forms. Surface quality and surface finish/surface integrity and its effect on product properties.

Tolerance Analysis:

Producing accuracies and attainable accuracies- process capability relation with statistical accuracies, prime accuracies, tolerance chart, tolerance grades and its calculations, tolerance stack, tolerance analysis for assembly.

Unit-III (8)

Work-piece control and selection of operations:

Causes of work-piece variations, variables influencing work-piece control, equilibrium theories, mechanical, geometrical and dimensional control, Concept of location – fundamentals of locating, datum features, errors in location and clamping, establishing process areas, guidelines for identifying holding areas, supporting areas and critical areas.

Study of basic process operations, principal processes and auxiliary processes, Identification of major, critical, qualifying, re-qualifying and supporting operations. Selection of single or combined operations, Identification of finishing operations, Establishing manufacturing sequence.

Unit- IV (11)

Equipment & Tooling Selection:

Factors to be considered in equipment/machine selection, determining machine up and down time. Types of tooling, Factors affecting selection of tooling, use of multi-tooling set-up. Process Sheet Design: Study of the part-print , logical design of process plan, stock preparation, blank size selection with material estimates, Selection of datum surfaces, identification of machining surfaces, dimension and tolerance analysis, selection of machining methods with time estimates and standard time for each operation, Preparation of process picture sheet and operation route sheet for complete manufacturing part.

Unit-V (8)

Process Selection and Capacity Planning

Component of process selection, Factor affecting on process selection decisions, Deigning the process (Process flow analysis ,Process Re-engineering, Product –Process Mix, Operations Strategy, Capacity utilization, Capacity Planning, Importance of capacity decisions, Defining and measuring capacity, Dimensions of capacity, Determining capacity requirements, Developing capacity alternatives, Factors determining effective capacity, Introduction to theory of constraints ,OEE and its calculation,

Unit- VI (5)

Computer aided process planning

Advantages over manual process planning, approaches for CAPP: Generative Process Planning, Knowledge-based Process Planning, Feature Recognition in Computer Aided Process Planning, recent trends

Text Books:

1. Eary D. F., Johnson G. E., “Process Engineering for manufacture” Prentice Hall of India Pvt. Ltd.
2. Narayana K. L., Kannaiah P., Vankata Reddy K., “Production Drawing”, New age international Publishers.
3. Groover Mikell P., Automation, Production Systems, and Computer-Integrated Manufacturing, Third Edition, PHI Learning Private Limited.

Reference Books:

1. Scallan P., “Process Planning- Design/Manufacture Interface”, John Wiley & Sons, 1995.

311096 : Seminar and Technical Communication

Teaching Scheme	Credit Scheme	Examination Scheme
Seminar:1 hours / week	Pr/Or: 01	Oral: 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 Oral examination will be based on the report submitted and (orally) presented.

311097 : Numerical Techniques and Optimization Method Lab

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

Practical:

1. Review of C/Matlab programming
   C/Matlab program for any three from practical No. 2 to 6:
2. Solution of Algebraic/ Transcendental Equation
3. Solution of Linear simultaneous equations
4. Solution of Curve Fitting
5. Solution of Numerical Interpolation
6. Solution of ordinary differential equation
7. Numerical integration using Matlab.
8. Case study on manufacturing optimization
9. Creation and Addition/Deletion Modification of existing Database using SQL.
10. Creation of Database Application for Purchase/Manufacturing/Logistics and its report generation using Oracle/VB/VC++/Microsoft Access.

311098 : Machine Tool Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours / week	Pr/Or: 01	Term work : 50 Marks

Term Work:
Term work shall consist of:
1. Assignments based on each topic of the syllabus.
2. A industrial visit to any gear manufacturing/thread manufacturing/automation industry and report based on it.
3. A simple program on CNC Turn / CNC Mill / CNC Drill.

311099 : Process Planning and Tool Selection Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hours / week	Pr/Or: 01	Term work : 50 Marks

Term Work:
Term work shall consist of assignments based on following topics:

1. Part print analysis of one industrial component drawing.
2. Process sheet design of one component on GPM for Batch Production.
3. Process sheet design of one component for mass production.
4. Time estimation for assembly using flow-charting techniques.
5. One case study on two level full factorial experimental design using DOE technique.
6. One case study on Taguchi Analysis using Orthogonal Arrays.

Process sheet design shall include detailed analysis of part print, planning the best sequence of machining operations, selection of proper equipment and tooling, Selection of datum surfaces, stock preparation and blank size selection, machining time calculations, time estimates and standards, design of jigs & fixtures, design of special tooling such as form tool if required, suggest appropriate inspection methodology, preparation of process picture sheets and operation route sheet etc.

311100 : Tool Design Lab

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

Term Work (Any four of the following)
1. Design and drawing of Progressive die.
2. Design and drawing of die.
3. Design and drawing of Forging die.
4. Design & Drawing of Blanking die.
5. Design and drawing of single cavity injection mould. (All drawings on A2 size drawing sheet)

Syllabus

Savitribai Phule Pune University

Faculty of Engineering

Fourth Year Production Engineering

(Course 2015)

(with effect from June 2018)

Savitribai Phule Pune University, Pune
Syllabus for Fourth Year Production Engineering
(2015 Course)
(With effect from Academic Year 2018-19)

Semester- I

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/ TUT	PR/OR
					In-Sem	End-Sem						
411081	Machine Tool Design	3			30	70				100	3	
411082	Automation & Control Engineering	3			30	70				100	3	
411083	Operations Research	4			30	70				100	4	
411084	Elective I	3			30	70				100	3	
411085	Elective II	3			30	70				100	3	
411086	Machine Tool Design Lab		2					50		50		1
411087	Automation & Control Engineering Lab		2						50	50		1
411088	Operations Research Lab		2				50			50	1	
411089	Elective I Lab		2				50			50	1	
411090	Project Phase-I		2				50			50	1	1
											19	**3**
	Total	**16**	**10**	**0**	**150**	**350**	**150**	**50**	**50**	**750**	**22**	

Elective I
(a) Product Design & Development
(b) Financial Management and Costing
(c) Data Analytics
(d) Advanced Thermal Engineering
(e) Mechatronics

Elective II
(a) Nano Manufacturing
(b) Simulation & Modeling
(c) Additive Manufacturing
(d) Reliability Engineering
(e) Advanced Materials

Abbreviations:

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

Savitribai Phule Pune University, Pune
Syllabus for Fourth Year Production Engineering
(2015 Course)
(With effect from Academic Year 2018-19)

Semester- II

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/ TUT	PR/OR
					In-Sem	End-Sem						
411091	Computer Integrated Design & Manufacturing	3			30	70				100	3	
411092	Industrial Robotics	3			30	70				100	3	
411093	Elective III	3			30	70				100	3	
411094	Elective IV	3			30	70				100	3	
411095	Computer Integrated Design & Manufacturing Lab		2						50	50		1
411096	Industrial Robotics Lab		2					50		50		1
411097	Elective III Lab		2				50			50	1	
411098	Elective IV Lab		2				50			50	1	
411099	Project Work			6			50	100		50	1	5
											15	**7**
	Total	**12**	**8**	**6**	**120**	**280**	**150**	**150**	**50**	**750**	**22**	

Elective III
(a) Sustainability Engineering
(b) Supply Chain Management
(c) Automobile Engineering
(d) Entrepreneurship
(e) Human Resource & Management

Elective IV
(a) Intelligent Manufacturing System
(b) Energy Management
(c) World Class Manufacturing
(d) Finite Element Analysis
(e) Environmental Engineering

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

411081: Machine Tool Design

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

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Pre-requisites: Machine Tool Operations, Mechanics of Materials and Design of Machine Elements, Kinematics of Manufacturing Machines.

Course objectives:

1. An ability to apply knowledge of Machine tool Design.
2. An ability to identify & solve engineering problems.
3. An ability to identify, conduct experiment as well as analyze the data.
4. An ability to design a system, component to meet the desired needs of subject to constraints.
5. Proficiency in process, assembly and product engineering:-Understand the design of machine tool design.
6. Proficiency in manufacturing. Competitiveness:-understanding the creation of competitive advantage through manufacturing planning, strategy & control of Machine tool design.
7. Proficiency in machine tool design: understanding the analysis of machine tool engineering.

Outcomes:

After learning this subject, the student will be able do:

1. Design multi-stage gear box for machine tool applications
2. Design machine tool structures and element so machine tools such as bearings, powers crews, guideways etc.
3. Perform the analysis of vibration and dynamic characteristics of machine tools
4. Design special purpose machine tools

Unit I: Gear Box Design [8]

Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box.

Unit II: Design of Machine Tool Structures [7]

Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables. Design of spindle and spindle support using deflection and rigidity analysis, analysis of Antifriction bearings, preloading of antifriction bearing.

Unit III: Design of Guide ways and Power Screw [7]

Functions and types of guide ways, design criteria and calculation for slide ways, design of Hydrodynamic, hydrostatic and aerostatic slide ways, Stick-Slip motion in slide ways. Design of power screws: Distribution of load and rigidity analysis.

Unit IV: Controls and Stability of machine tools [7]

Dynamic characteristic of the cutting process, Stability analysis, vibrations of machine tools. Control Systems: Mechanical and Electrical, Adaptive Control System, relays, push button control, electrical brakes, drum control.

Unit V: Special Features of Machine Tools [7]

Design considerations of Stepless drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking, Machine tool monitoring and safety.

Unit VI: Recent Trends of Machine Tool Design **[7]**

Recent trends in machine tools, Design considerations for SPM, NC/CNC, Micro/Nano machining, Retrofitting, Autonomous machine tool, Installation, Calibration and Machine tool testing.

References:

1. Mehta N.K., "Machine Tool Design and Numerical Control", Tata McGraw Hill,2002, ISBN 0-07-451775-9.
2. Bhattacharya A. and Sen S.G., "Principles of Machine Tool", New central book agency Calcutta, 2009,ISBN 81-7381-1555.
3. Pal D.K., Basu S.K., "Design of Machine Tool", 4th Edition. Oxford IBH 2005,ISBN:81204-0968.
   Date P. P., "Introduction to Manufacturing Technology, Principles and Practices", , Jayco Publishers, Mumbai,2010, ISBN8179929973, 9788179929971
4. Koenigsberger F., "Design Principles of Metal Cutting Machine Tools", The MacmillanCompany, New York ,1964.
5. CMTI Banglore, "Machine tool design handbook" Tata McGraw-Hill, New Delhi, 1982

411082: Automation & Control Engineering

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

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Pre-requisites: Basic Electronics Engineering, Basic electrical engineering, Heat and fluid engineering

Course objectives:

1. To learn Basic principles of Industrial hydraulics.
2. To study design of hydraulic circuits & selection of various components.
3. To study pneumatic systems & circuit.
4. To understand concept of programmable automation viz microprocessor & control.
5. To study various control system & learn of programmable logic control.
6. To get well verse with the factory automation methods & system.

Outcomes: After learning this subject, the student will be able to:

1. Understand basic concepts of industrial hydraulics and pneumatics
2. Design the hydraulic and pneumatic circuits for given application
3. Use microprocessor and programmable logic controller for soft automation.
4. Apply electric, electronics and computer control systems used in automation.
5. Apply various innovative methods for factory automation.

Unit I: Introduction to Hydraulic Systems [7]

Introduction of fluid power system, Properties of fluids, Fluids for hydraulic systems, governing laws. Standards in circuit diagram representation, hydraulic symbols, Working Principle, design and analysis of reservoir, pumps, filters, valves, actuators, accumulators, intensifiers.

Unit II: Design and Analysis of Hydraulic Circuits [7]

Design considerations for hydraulic circuit, Detail analysis speed control, flow control, pressure control circuits, Industrial applications of hydraulic circuit design using proportional valves and servo valves.

Unit III: Pneumatic Systems [7]

Operational principles, Functions of different pneumatic components and selection, Valves for logic functions; Time delay valve; Examples of typical circuits using Displacement – Time and Travel-Step diagrams, cascade circuits, Construction of pneumatic controls and circuit diagrams for conveying, feeding, clamping, indexing, cutting and non-cutting operations.

Unit IV: Programmable Automation [7]

Microprocessor - Basic architecture and its Busses, programming model, internal data operation and registers, controls and status signals, instruction sets, addressing modes.

Microcontroller: Microcontroller based manufacturing systems.

Unit V: Control System **[7]**

Data conversion (ADC/DAC), Programmable logic controller, Interfacing circuits, Actuating signals, relays, contactors, Types of control systems- P, PI, PID , Optimal control system.

Case studies on electrohydraulic and electro-pneumatic circuits.

Unit VI: Advance Automated Systems **[7]**

Large scale control systems: Supervisory control and data Acquisition (SCADA), Human machine interface (HMI), Remote Terminal Unit (RTU), Digital Communication Unit (DCU).

Robotic systems: Manipulator kinematics, trajectory planning,

Artificial Intelligence in automation: Artificial Neural Networks, Fuzzy Logic, Image Processing

Text Books:

1. Kuo B.C., "Automatic control systems", Prentice Hall India Pvt. Ltd., New Delhi, ISBN: 1305-5070-1
2. Peter Rohner, "Industrial hydraulic control", Wiley Edition, 1995, ISBN: 0471334987
3. Mikell P Groover, "Automation, Production System and Computer Integrated Manufacturing", Prentice Hall Publications, ISBN 9789332549814
4. Mujumdar S.R., "Pneumatic System", Tata McGraw Hill, 2002 Edition. ISBN: 9780074602317
5. Gopal, "Control Systems Engineering", Willey Eastern Ltd., ISBN 0-85226-605-7.

Reference Books:

1. Doebelin E.O, "Measurement System, Application and Design", Tata McGraw HillPublications Ltd., New Delhi, ISBN 0-07—17338-9.
2. Bolton W., "Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education (Singapore) Pvt Ltd., ISBN 81-7808-339-6.
3. Rangan C.S., Sharma G.R., Mani V.S., "Instrumentation - Devices and Systems", Tata McGraw Hill Publications Ltd., New Delhi, ISBN 0-07-463350-3.
4. Histand B.H., Alciatore D.G., "Introduction to Mechatronics and Measurement Systems", ISBN 0-07-052910-8.
5. Johnson C.D., "Process Control Instrumentation Technology", Prentice Hall of India pvt.Ltd., New Delhi, ISBN 81-203-0987-1.
6. HMT Mechatronics, HMT, ISBN 0-07-462147-5.
7. Vickers manual on hydraulics

411083: Operations Research

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 04 hours / week	Theroy: 04	In-Sem: 30 Marks End-Sem: 70 Marks

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Pre-requisites: Engineering Mathematics-III, Industrial Engineering, & Management, Production Management

Course objectives:

1. To introduce the students how to use variables for formulating complex mathematical models in business management, industrial engineering and transportation engineering.
2. To provide the students with opportunity of using various software package for solving linear programming and integer programming models
3. To introduce the students to the use of basic methodology for the solution of linear programs and integer programs.
4. To introduce the students to the basic concepts of polyhedral theory and valid inequalities and how to integrate the theory to the solution methods for integer programming.
5. To introduce the students to the advanced methods for large-scale transportation and assignment problems.
6. To familiarize students with the basic concepts, models and statements of the operations research theory.

Outcomes:

After learning this subject, the student will:

1. Know principles of construction of mathematical models of conflicting situations and methods of operations research
2. Be able to choose rational options in practical decision-making problems using standard mathematical models of operations research
3. Have skills in analysis of operations research objectives, mathematical methods and computer systems.
4. Use mathematical software to solve the proposed models.
5. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems
6. Be able to take decisions with a quantitative basis and improves quality of decisions.

Unit I: Linear programming (LP) [8]

Definition of Operations Research: Objectives, Simplex methods for maximization and minimization problems: Formulation, Degeneracy in L.P., Duality in L. P.

Unit II: Transportation and Assignment problem [8]

Transportation problems- Use of various methods for solving transportation problem, Degeneracy and its solution, Transshipment problem.

Assignment problem- Solutions of various types of problems: Hungerian Method, Branch & Bound Technique, travelling salesman problem.

Unit III: Introduction to Integer, Dynamic and Non-linear programming [8]

Integer programming, Branch & Bound method, Cutting Plane method, Dynamic programming introduction, application, capital budgeting, different problems solved by dynamic programming,

Geometric and goal programming, Definition, Introduction, Application of geometric and goal programming

Unit IV: Replacement models [8]

Replacement of capital equipment that deteriorates with time, Time value of money: Cases in which time value of money remains same and changes with constant rates during period. Group and individual replacement.

Unit V: Decision Theory and Games Theory [8]

Decision Theory: steps in decision theory, Decision making under conditions of certainty, uncertainty and risk, maximum likelihood criterion, Expected value criterion

Games Theory: Introduction, Terms and definitions, Solution methods

Unit VI: Queuing theory and Simulation [8]

Operating characteristics, Poisson single and multi channel queuing system (M/M/1): (∞/∞/FCFS), (M/M/1): (∞/∞/SIRO),(M/M/1): (N/∞/FCFS), (M/M/c): (N/∞/FCFS)

Monte Carlo simulation of Production quantity, Demand, Inventory, Queuing systems, Investment decision etc.

Text Books

1. Sharma S.D., “Operations Research”, Kedarnath Ramnath and company publications.
2. Gupta P.K., Hira D.S., “Operations Research”, S Chand and Co. Ltd., New Delhi ISBN: 8121902819
3. Taha H.A., “Operations Research - An introduction”, Prentice Hall Pvt. Ltd.
4. P. Shankaralyer, “Operations Research” Sigma Series, Tata McGraw-Hill. ISBN: 1283922487
5. Rao, S. S. “ Engineering Optimization: Theory and Practice”, John Wiley & Sons. ISBN: 0470183527

Reference Books

1. Hillier F.S., Lieberman G.J., “Introduction to Operations Research”, Tata McGraw-Hill, ISBN: 0071333460
2. Wagner H.M., “Principles of Operations Research”, Prentice-Hall India, ISBN: 0137095929
3. Ravindran A., “Operations Research”, Tata McGraw-Hill. New Delhi. ISBN:1420091875
4. Basu S.K., Pal D.K., and Bagchi H., “Operations Research for Engineers”, Oxford and IBH Publishing Co. Pvt. Ltd.,
5. Panneerselvam R., “Operations Research”, Prentice Hall of India Ltd., New Delhi. ISBN: 8120319230

411084(A): Elective I: Product Design and Development

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: Production Management

Course Objectives:

- To carry out the engineering design process for new product.
- To understand the generic product development process.
- Use of various analysis tools for product design & development.
- To understand the structure of PLM in organization

Course Outcomes:

After Successful completion of this course students will be able to

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

Unit I: Engineering Product Design [7]

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 [7]

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 [7]

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 [7]

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: Analysis Tool [7]

Design for Manufacture (DFM) and Design for Assembly (DFA): 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,

Minimize the system complexity.

Unit VI: Product Life Cycle Management (PLM) [7]

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, McGraw Hill, 3rd Edition, 2003.
2. Dieter and Schmidt , Engineering Design, McGraw – Hill Higher education, ISBN: 978–0– 07–283703–2
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 & DewburstP.,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

411084(B): Elective I: Financial Management and Costing

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 objectives:

- To provide thorough grounding of financial management concepts and preparation of Financial Statements with their analysis.
- To gain expert knowledge of principles and concepts used in finance
- To learn to manage short-term resources of a business firm
- To be able to find out the best course of action among several financial options
- To help understand costing and management accounting techniques that could be utilized for decision making and control.

Outcomes:

After learning this subject, the student will be able to:

1. Use Financial Statements to evaluate performance of a firm
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 [7]

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 [7]

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 [7]

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 [7]

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: [7]

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 [7]

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-X
3. M. Y. Khan, P. K. Jain, “Financial Management”, Tata McGraw Hill Publishing Ltd. ISBN: 933921305X
4. B. K. Bhar, “Cost Accounting Methods and Problems”, Academic Publishers, Calcutta, ISBN: 9380599617

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.

411084(C): Elective I: Data Analytics

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

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Pre-requisites: Engineering Mathematics III, Numerical Techniques and Optimization Methods

Course objectives:

The objective is to provide a basic understanding of data analysis using statistics and to use of computational tools on problems of applied nature.

Outcomes:

After learning this subject, the student will be able to:

1. Effectively visualize and interpret the data
2. Apply predictive and prescriptive techniques for production engineering applications
3. Use data analysis for engineering applications through the powerful tools of data application

Unit 1: Introduction to data analytics [7]

Significance & applications of data analytics, Data collection, data processing, data transformation, data integration, data visualization, basic statistics, inferential statistics

Unit 2: Descriptive analytics [7]

Uni-variate/multi-variate statistics, bi-variate associations, correlations, covariance, analysis of variance (ANOVA)

Unit 3: Predictive analytics [7]

Multiple regression, conjoint analysis, neural networks, data clustering, Data mining

Unit 4: Classification techniques [7]

Linear classifiers, Quadratic classifiers, Support vector machines, Random forests.

Unit 5: Prescriptive analytics [7]

Decision tree analysis, Expert system, principal component analysis, genetic algorithms

Unit 6: Reinforcement learning [7]

Markov chain analysis, Monte Carlo simulation, Q learning, State action reward state action (SARSA) learning

Books:

1. Acharya Seema and Chellappan, Big Data and Analytics, Willey India Pvt. Ltd. (2015), ISBN: 9788126554782
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Willey India Pvt. Ltd. (2016), ISBN: 978-1-118-87622-0
3. Michael Minelli, Michale Chambers, Ambiga Dhiraj, Big Data Analytics: Emerging Business Intelligence and analytics trends for today's business, Willey India Pvt. Ltd. (2015)

411084(D): Elective I: Advanced Thermal Engineering

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

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Pre-requisites: Basic Mechanical Engineering, Basic of Physics, Heat and Fluid Engineering

Course objectives:

1. To understand Basics concepts of thermodynamic
2. To develop an ability to apply knowledge of mathematics, science, and engineering.
3. To Learning the fundamental principles and different methods of refrigeration
4. To develop an ability to apply the knowledge of Heat transfer in Manufacturing System
5. To understand the concept power generation System in various forms

Outcomes:

After learning this subject, the student will:

1. Apply laws of thermodynamics to devices viz. engines, refrigerators etc.
2. Analyze and compare air standard cycles, steam power cycles
3. Understand the principle of power generation system and devices used in steam power plant.
4. Understand and analyze basic modes of heat transfer
5. Explain the design, performance analysis and practical applications of heat exchangers.

Unit I: Introduction to thermodynamic [7]

Heat and work, reversible process, irreversible processes, Ideal Gas Equation Ideal gas Processes, Enthalpy, entropy Steady flow energy equation (SFEE) and its application (boiler, turbine, compressor, Nozzle), Air standards Cycles

Unit II: Introduction to Power Plant Engineering [7]

Steam power plant, working of Steam power plant, Carnot vapour power cycle, Rankine cycle, comparison between Carnot and Rankine cycle, irreversibility and losses in vapour power cycle, effect of operating variables on Rankine cycle, reheating of steam

Gas turbine Power Cycles (Brayton cycle analysis) , Open, Closed & Semi Closed cycles Gas Turbine Plant , combined cycle plant

Unit III: Non-Conventional Power Plants [7]

Wind Power plant : Introduction, wind availability measurement, types of wind machines, site selection, and wind power generation.

Solar Power Plant : Introduction, components ,Types of Collectors & Solar Ponds, Low & High Temperature Solar Power Plant. Photovoltaic Power System, Heliostat Tidal, OTEC, geothermal, magneto hydrodynamics, fuel cell, hybrid power plants, Challenges in commercialization of Non-Conventional Power Plants.

Unit IV: Introduction to Refrigeration [7]

Definition of Refrigeration, Refrigerators and Heat Pumps, Refrigeration terminology, types of refrigeration systems, gas refrigeration Systems, Brayton refrigeration cycle, Bell Coleman cycle, ideal vapour compression refrigeration cycle (Numerical treatment with p-h chart), vapour absorption refrigeration cycle, refrigerants, classification of Refrigerant, Ozone Potential depletion, kyoto protocol, Montreal Protocol.

Energy V: Introduction to heat transfer **[7]**

Introduction To Heat Transfer: Introduction, modes of heat transfer, steady state heat transfer, thermal conductivity and coefficient of heat transfer, Convective Heat Transfer: Introduction to natural and forced convection, empirical relation, significance of different non dimensional numbers in convective heat transfer, Radiation Heat Transfer: Introduction, definitions, laws of radiation, surface resistance, Radiations shields, Electrical analogy for steady radiation problems.

Unit VI: Heat Exchangers: **[7]**

Classification, concept of overall heat transfer coefficient, LMTD relations, effectiveness, and effectiveness by NTU method, Simple Numerical Case studies of Heat Transfer in Manufacturing Sector (Casting, Welding etc.)

Textbooks:

1. P. K. Nag, Engineering Thermodynamics: Tata Mc-Graw Hill publication
2. Yunus A. Cengel, Michael A. Boles, Thermodynamics-An Engineering approach: Mc-Graw Hill publication
3. - P. K. Nag, Tata Power Plant Engineering Mc- Graw Hill Publications, Third Edition
4. S. Domkundwar Power Plant Engineering -, Dhanpatrai & sons
5. R. K. Rajput, A Textbook of Refrigeration and Air-Conditioning, S.K.Kataria& Sons
6. C.P. Arora, Refrigeration and Air-conditioning, TMH Pub.
7. Incropera & Dewitt J. Introduction to Heat Transfer, Wiley, John Wiley & Sons
8. Heat Transfer: S. P. Sukhatme, Universities Press

Reference Books:

1. P.L. Balaney, Thermal Engineering: Khanna Publisher.
2. Michael J. Moran, Howard N. Shapiro, Fundamentals of Engineering Thermodynamics: Mc-Graw Hill publication
3. M. M. Wakil, Power Plant Engineering, Mc-Graw Hill.
4. Black and Veatch, Power Plant Engineering, CBS Publisher and Distributors
5. Jordon & Priestar, Refrigeration & Air-conditioning,PHI Publication.
6. Yunus A Cengel, Heat Transfer, Mc Graw Hill
7. J P Holman, Heat Transfer, Mc Graw Hill
8. D. S. Kumar , Heat Transfer, S K Kataria & Sons
9. C P Kothandaraman, Fundamentals of Heat & Mass Transfer, New Age Techno Press

411084(E): Elective I: Mechatronics

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

Pre-requisites: Engineering Mathematics III**,** Basic Electrical Engineering, Basic electronics Engineering

Course objectives:

1. To provide knowledge about types of system, sensor, transducers.
2. To provide knowledge about filters and amplifiers used in electrical circuits.
3. To make aware students about applications of Mechatronics system to automate manufacturing processes .

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 [7]

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

UNITII: Analog Signal Conditioning [7]

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 [7]

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 [7]

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 Responses

UNIT V: Control System [7]

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 [7]

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 Book

1. C D Johson, Process Control Instrumentation Technology, 7th Edition, 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 Book

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

411085(A): Elective II: Nano Manufacturing

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

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Pre-requisites: Machine Tool Engineering Material, Material Forming, Metrology & Quality assurance

Course objectives:

1. To give awareness of different techniques used in nano manufacturing
2. To give in-depth idea of the conventional techniques used in nano manufacturing
3. To introduce Non-conventional nano manufacturing and finishing approaches
4. To introduce Nanofabrication Techniques
5. To know different techniques used in metrology tools in micro and nano manufacturing.

Outcomes:

After learning this subject, the student will able to:

1. Distinguish between micro and nano manufacturing and identify the various finishing approaches.
2. Identify the applications of conventional and non-conventional manufacturing processes.
3. Distinguish various nano finishing processes.
4. Measure the micro and nano scales.

Unit -I: Precision Engineering [7]

Introduction to conventional micro machining, Non-conventional micro-nano manufacturing and finishing approaches, Introduction to Nanotechnology

Unit -II: Precision Machining Processes [7]

Process principle, description and applications of conventional micro-nano machining processes such as: turning, drilling, milling and grinding Process principle, description and applications of non-conventional micro-nano machining processes such as: Micro EDM, Micro WEDM, Micro EBM, Micro ECM, Micro LBM, Photo Chemical Machining.

Unit -III: Precision Forming Processes [7]

Micro extrusion- process and applications, Nano- Plastic forming and Roller Imprinting, micro bending with Laser

Unit -IV: Nano Finishing Processes [7]

Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications

Force analysis of MRAFF process, Elastic Emission Machining (EEM) – machine description, applications, Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications

Unit -V: Nanofabrication Techniques [7]

Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp), Manipulative techniques – process principle, applications, Introduction to Carbon nano materials, Carbon nano tubes – properties and applications, Laser Micro welding – description and applications, Defects, Electron Beam Micro-welding – description and applications

Unit -VI: Micro and nano Measurements [7]

Introduction to On-Machine Metrology, Defining themicro and nano scale, uncertainty, Scanning Electron Microscopy – description, principle, Scanning White-light Interferometry – Principle and application, Optical Microscopy – description, application, Confocal Microscopy - description, application

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. N P Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V. K. Jain, Micro-manufacturing Processes, CRC Press, 2012.

411085(B): Elective II: Simulation and Modeling

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

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Pre-requisites: Numerical Techniques and optimization, Production Management

Course objectives:

1. Introduce students to the simulation and modeling techniques
2. Provide students with opportunities to develop basic simulation and modeling skills with respect to carrying out research projects using any simulation method on the computer.

Outcomes:

After learning this subject, the student will able to:

1. Solve the problems based on simulation principal
2. Differentiate the simulation systems.
3. Collect data and generate the random numbers.
4. Distinguish simulations with regard to output analysis
5. Apply simulation to manufacturing system.
6. Handle software packages – ARENA/SimFactory/Promodel/ Witness

Unit I: Principles of Simulation and Modeling [7]

A review of basic probability and statistics, Definition and concepts of simulation and modeling, steps in a simulation study, Modeling concepts, Advantages, Disadvantages and Applications areas of simulation Basic principles of simulation modeling, Model based problem solving

Unit II: System Simulation [7]

Types of simulation: Physical vs. Mathematical, Static vs. Dynamic, Deterministic vs. Stochastic, Continuous vs. Discrete simulation models, Continuous, Discrete event, Monte-Carlo simulation methods and their applications in inventory and queuing problems (single server queuing system) – problem organization and logic.

Unit III: Input Data Analysis [7]

Nature of simulation, Roots of simulation input modeling, Data collection, Identifying distribution, Histograms, practical methods for testing assumptions

Random Number Generation: Introduction, Desired properties, Generation of pseudo random numbers

Unit IV: Random Variate Generation [7]

Introduction, Factors considered in selecting generator, generating continuous random variates like Uniform, Exponential, Weibull, Normal

Output Data Analysis: Introduction, Types of simulations with regard to output analysis – terminating and non

Terminating simulation

Unit V: Simulation of Manufacturing Systems **[7]**

Need of simulation in manufacturing and material handling systems, Components of manufacturing systems – product, resources, demand, control; Downtime, Rework and reentrancy, Random events and performance measures used in manufacturing systems with a case study on any manufacturing system Material Handling Systems – Input parameters for automated material handling systems, Conveyor and vehicle systems, job shop with material handling and flexible manufacturing systems.

Unit VI: Simulation Software **[7]**

Simulation software: Introduction, Comparison of simulation software with programming languages – SLAM, SIMAN. Desirable software features, Classification of simulation software, General purpose and object oriented simulation software packages – ARENA/SimFactory/Promodel/ Witness

Text Books:

1. Averill M Law, "Simulation Modeling and Analysis", Fourth Edition, Tata McGraw Hill Education Private Ltd, New Delhi, 2010.
3. Banks, J., J. S. Carson II, and B. L. Nelson. "Discrete-Event System Simulation", Second Edition, Prentice Hall, 1996.
4. Bratley, P., B. L. Fox, and L. E. Schrage "A Guide to Simulation", 2nd ed., Springer-Verlag, 1987.
5. Fishman, G.S., "Monte Carlo: Concepts, Algorithms and Applications", Chapman & Hall, New York, 1996.

References:

1. Jerry Banks (Ed.), "Handbook of Simulation – Principles, Methodology, Advances, Applications and Practice", Wiley – Interscience Publication, 1998.
2. Gordon G., "System Simulation", 2nd Edition, Prentice Hall,1978
3. Nelson, B. L., "Stochastic Modeling: Analysis and Simulation", McGraw-Hill, New York, 1995.

411085(C): Elective II: Additive Manufacturing

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

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Pre-requisites: Material Science, Computer Aided Design

Course objectives:

1. To know the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Additive Manufacturing technologies
2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

Outcomes:

After learning this subject, the student will:

1. Identify the materials for used in additive manufacturing.
2. Identify the software for additive manufacturing and digitization techniques.
3. Identify industrial applications of liquid based additive manufacturing technology.
4. Identify industrial applications of solid based additive manufacturing technology .
5. Identify the industrial applications of powder based additive manufacturing.
6. Find applications of Bio-Additive Manufacturing- Computer Aided Tissue Engineering

UNIT I: Introduction **[7]**

Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling – Applications,3D modeling ,Data Conversion, Checking and Preparing, Building, Post processing

UNIT II: CAD & Reverse Engineering **[7]**

Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS

UNIT III: Liquid Based Additive Manufacturing Systems **[7]**

Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications , Cubital's Solid Ground Curing (SGC), D-MEC's Solid Creation System (SCS), Meiko's Rapid Prototyping System for the Jewelry Industry, Rapid Freeze Prototyping, Microfabrication

UNIT IV: Solid Based Additive Manufacturing Systems **[7]**

Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Cubic Technologies' Laminated Object Manufacturing (LOM), Kira's Paper Lamination Technology (PLT), 3D Systems' Multi-Jet Modeling System (MJM), Beijing Yinhua's Slicing Solid Manufacturing (SSM), Melted Extrusion Modeling (MEM) and Multi-Functional RPM Systems (M-RPM)

UNIT V: Powder Based Additive Manufacturing Systems **[7]**

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting.

UNIT VI: Medical and Bio-Additive Manufacturing [7]

Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies, Biomedical applications of AM-Operation Planning for Cancerous Brain Tumor Surgery, Planning Reconstructive Surgery with RP Technology, Craniofacial Reconstructive Surgery Planning, Biopsy Needle Housing, Knee Implants, Scaffolds for Tissue Engineering, Customized Tracheobronchial Stents, Inter-Vertebral Spacers, Cranium Implant

TEXT BOOKS:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCES:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

411085(D): Elective II: Reliability Engineering

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

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Pre-requisites: Metrology and Quality Control

Course objectives:

1. To focus on static and dynamic reliability of complex systems.
2. To study graphical techniques and empirical distributions.
3. To utilize common physical models for reliability analysis.
4. To study how to perform reliability analysis of complete data.
5. To study root cause, correct, and document system failures.
6. To study the failure Mode and its interactions.

Outcomes:

After learning this subject, the student will able to:

1. Identify and analyze the static and dynamic reliability of complex systems.
2. Identify commonly used reliability techniques using graphical techniques and empirical distributions.
3. Utilize common physical models for reliability analysis.
4. Perform reliability analysis of complete data.
5. Acquire ability to root cause, correct, and document system failures.
6. Implement accelerated and highly accelerated life testing analyses.

Unit I: Fundamentals of Reliability Engineering [7]

Reliability definition, reliability concept, quality, failure, patterns of failure, causes of failure, Time to failure Distributions–experimental, Weibull, gamma, normal, log normal, extreme value, model selection for components failure, failure analysis. failure density, failure rate, hazard rate, MTTF, MTBF,MTTR, MDT, unreliability, factor of safety and reliability, areas of reliability, life characteristic phases, bath-tub curve, Elements of Probability theory: Set theory, total probability theorem, Bayes rule.

Unit II: System reliability and modeling: [7]

Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, matrix method, cut-set and tie-set method, Redundancy, element redundancy, unit redundancy, standby redundancy- types of standby redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.

Unit III: Maintainability and Availability [7]

Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time, Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off.

Unit IV: System reliability Analysis [7]

Reliability allocation or apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment, dynamic programming apportionment, Evaluation of overall system reliability, Reliability block diagrams and models, Reliability predictions from predicted unreliability, minimum effort method.

Unit V: Failure Mode, Effects and Criticality Analysis [7]

Failure mode effects analysis, severity/criticality analysis, FMECA examples, RPN, Ishikawa diagram for failure representation, fault tree construction, basic symbols development of functional reliability block diagram, fault tree analysis, fault tree evaluation techniques, minimal cut set method, Delphi methods, Monte carlo evaluation.

Unit VI: Reliability testing and Failure Interactions and Terro-technology [7]

Reliability growth models, grouped and ungrouped data, censored data, accelerated life testing, Markov analysis of two independent components, reliability with standby system, multi component systems, DTMC and CTMS models. Terro-technology, application of terro technology.

Text Books:

1. L.S. Srinath, Concepts of Reliability Engg., Affiliated East-West Press (P) Ltd., 1985.
2. E. Balagurusmy, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1984.
3. Bhadury B., Basu S. K., Terotechnology-Reliability Engineering and maintenance‖, Asian Books Private Limited, ISBN 81-86299-40-6.

Reference Books

1. A.K. Govil, Reliability Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1983.
2. B.S. Dhillion, C. Singh, Engineering Reliability‖, John Wiley & Sons, 1980.
3. M.L. Shooman, Probabilistic Reliability‖, McGraw-Hill Book Co., 1968.
4. P.D.T. Conor, Practical Reliability Engg‖, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design‖, John Wiley & Sons, 1977.
6. A.Birolini , Reliability Engineering, Theory and Practice‖, Third Edition, Springer, 1999
7. Rao S. S., Reliability Engineering‖, McGraw Hill.

411085(E): Elective II: Advanced Materials

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

Pre-requisites: Material Science and Engineering Metallurgy

Course objectives:

1. To develop futuristic insight into materials
2. To acquaint students with basic concepts, properties and applications of different materials
3. To acquire the skills and techniques necessary for modern materials engineering practice

Outcomes:

After learning this subject, the student will:

1. Understand and possess the knowledge of working on materials.
2. Gain the knowledge of properties and applications of different materials
3. Select the appropriate material and prevent failure.

Unit I: Electrical and Magnetic Materials [7]

Electrical conducting materials, Electric contact materials, Applications of semiconductor materials, Dielectric Materials and Insulation: Polarization, Polarization Mechanisms, Dielectric Constant, Dielectric Loss, Piezoelectric, Ferro Electric and Pyroelectric Materials, Permanent Magnet materials, Feebly magnetic materials

Unit II: Nanomaterials [7]

Introduction, Unique properties of nanomaterials, Applications of nanomaterials- Nano electronics, Micro-and-Nano-electromechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, Structure and Engineering, Automotive Industry, Nano-medical applications, Tools to characterize Nanomaterials- XRD, SEM, TEM, AFM, STM, FIM, 3DAP, Nanoindentation

Unit III : Polymers [7]

Introduction, Formation of polymers, Classification of polymers, Polymerization mechanisms, Degree of polymerization and it's numericals, Crystallization of polymers, Cross-linking, Deformation of polymers, Factors affecting the properties of a polymer, Applications of polymers

Unit IV: Elastomers [7]

Introduction, Characteristics of rubber, Uses of rubber, forms of rubber, Plasticization, Compounding, Calendering, Vulcanisation, Extruding, Moulding, Reclaimed rubber, Properties of elastomers

Unit V: Ceramic Materials [7]

Introduction, Classification of ceramics, Advantages, Applications and Properties of ceramic materials, Advanced structural ceramics, WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications, Properties and applications of Glass, Properties and applications of Refractories

Unit VI: Composite Materials [7]

Reinforced fibers, Particle strengthened and laminar composites-- production techniques of each type, Production of fibers, properties mechanics of composites, manufacturing of metal matrix,Ceramic matrix composite, Carbon-Carbon composite- properties and testing of composite material, areas of application.

Text Books

1. O.P.Khanna, "A Text Book of Material Science and Metallurgy", Dhanpat Rai Publications(P) Ltd., 2013, ISBN- 978-81-89928-31-5
2. V.D.Kodgire, S.V. Kodgire,"Material Science and Metallurgy for Engineers", Everest Publishing House, 24th Edition, 2008, ISBN 81 86314 00 8.
3. B.S. Murty, P.Shankar, Baldev Raj, B.B.Rath, James Murday, "Textbook of Nanoscience and Nanotechnology, Universities Press (India) Pvt. Ltd., 2013, ISBN : 978 81 7371 7383
4. R.K.Rajput, "A Textbook of Material Science and Engineering",S.K.Kataria and Sons, 3rd Edition, 2011, ISBN 81-85749-92-2

References:

1. W.D.Callister,Jr., "Callister's Materials Science and Engineering", 7th edition, Wiley India Pvt. Ltd., 2010,ISBN-978-81-265-2143-2
2. ASM Hand Book, Vol.11, "Failure Analysis and Prevention ".
3. W.F.Smith, "Principles of Materials Science and Engineering",3rd edition, McGraw Hill, ISBN: 0070592411

411086: Machine Tool Design Lab

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

Practical/Design Assignments:

1. Design and working drawing of speed gear box
2. Design and working drawing of feed gear box
3. Study of step-less drives.
4. Design of machine tool structure.
5. Design for spindle and power screw.
6. Design for guide ways and slide ways.
7. Practical Case study on Machine tool – testing , safety and calibration .

411087: Automation & Control Engineering Lab

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

The term work shall consist of assignments based on the following topics. Evaluation of practical will be based on practical examination.

Practical Work: (Any six from 1 to 7, 8th and 9th are compulsory)

1. Experiment on measurement of hydraulic pump efficiency.
2. Experiment on design of speed control hydraulic circuits.
3. Experiment on design of regenerative circuits
4. Experiment on design of electro-hydraulic sequencing circuits
5. Experiment on pneumatic circuits by demonstrating logic gates.
6. Experiment on electro-pneumatic circuits
7. Experiment on programmable logic controllers: Ladder logic programming
8. Microprocessor programming for basic operations.
9. *Industrial visit report on automation in any Industry.

* Industrial visit is compulsory.

Note: Use simulation software (freeware- fludsim, fluid demo etc) for doing experiments 1 to 7

411088: Operations Research Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term Work:

One exercise on each unit. At least one Computer Software Package such as Lindo/Lingo, MATLAB, MS-Excel/MS-Projects, Tora, AMPL etc. should be used. For each exercise along with manual solution of problems, any computer software package should be used to obtain the solution.

411089(A): Elective I: Product Design & Development Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 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

411089(B): Elective I: Financial Management and Costing Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 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

411089(C): Elective I: Data Analytics Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work shall consist of Programming/Assignment/Case studies on Data analysis based on each unit.

411089(D): Elective I: Advanced Thermal Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

The term work shall be based on the following assignments (any seven)

1. To determine thermal conductivity of composite wall.
2. To determine thermal conductivity of insulating powder.
3. To determine heat transfer coefficient in natural convection.
4. To determine heat transfer coefficient in forced convection
5. To determine Stefan Boltzman constant.
6. To determine the effectiveness of a concentric tube heat exchanger
7. To study construction and working of various solar photovoltaic (PV) systems
8. To study construction and working of various solar collectors
9. To study construction and working of various renewable energy systems
10. To determine the C.O.P. of vapour compression refrigeration test rig using P-H Chart
11. Report on visit to a cold storage/refrigeration plant/ Thermal power plant/hydroelectric power Plant.

411089(E): Elective I: Mechatronics Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Lab Work (any 6)

1. Measurement of Temperature
2. Measurement of Force using Strain Gauges
3. Measurement of Angular Velocity using proximity pickup/ encoders
4. Measurement of Displacement using LVDT
5. Demonstration of Op-Amps for Summing and Inverting Amplifier
6. PLC program for any real time example e.g. elevator, conveyor, bottle filling plant
7. Transient Response analysis of spring-mass balance system using MATLAB

411090: Project Phase-I

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 02(TW-1 & Oral-1)	Termwork: 50 Marks

Pre-requisite:

1. Students are required to undergo 3 to 4 weeks industrial training / implant training /in-house project based learning/project related skill development course/ industrial survey report before commencement of first semester of Final year .
2. Submit detailed report of 10-15 pages of the same.
3. Project registration will be based on completion of above activities.

The student shall take up a suitable project, the scope of the project shall be such as to complete it within the time schedule, the term work shall consist of:

1. Fabrication of models, machines, prototypes based on new ideas, robots and machine based on hi-tech systems and automation, experimental set-up, fabrication of testing equipment, renovation of machines, etc. **Students shall submit the project phase –II plan.** Above work shall be taken up individually or in groups. *The group shall not be more than 4 students,* ***(If project work is more then group members may be increased by permission of guide)***

OR

Extensive analysis of some problems done with the help of a computer individually or in a group not exceeding two students.

2. A detailed report on the work done shall include project specification, design procedure, drawings, process sheets, assembly procedure and test results etc. Project may be of the following types:

i. Manufacturing / Fabrication of a prototype machine' including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation
ii. Improvement of existing machine / equipment / process.
iii. Design and fabrication of Jigs and Fixtures, dies, tools, special purpose Equipment, inspection gauges, measuring instruments for machine tool,
iv. Computer aided design, analysis *of* components such as stress analysis.
v. Problems related to Productivity improvements/Value Engineering/Material Handling Systems
vi. Energy Audit of an organization, Industrial evaluation of machine devices.
vii. Design of a test rig for performance evaluation of machine devices.
viii. Product design and development.
ix. Analysis, evaluation and experimental verification of any engineering problem
x. Quality systems and management. Total Quality Management.
xi. Quality improvements, In-process Inspection, Online gauging.
xii. Low cost automation, Computer Aided Automation in Manufacturing.
xiii. Time and Motion study, Job evaluation and Merit rating
xiv. Ergonomics and safety aspects under industrial environment
xv. Management Information System.
xvi. Market Analysis in conjunction with Production Planning and Control.

OR

Computer based design / analysis or modeling / simulation of product(s), mechanism(s) or system (s) and its validation or comparison with available benchmarks / results. When a group of students is doing a project, names of all the students shall be included on every certified report copy. Two copies of project Report shall be submitted to the college. **The students shall present and submit their Project Phase-I report to the internal and external examiner from college/Industry.**

411091: Computer Integrated Design & Manufacturing

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

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Pre-requisites:
Engineering drawing, Machine drawing, Dimensioning and tolerances, various geometrical features. Design of Machine Elements

Course objectives: The students completing this course are expected to:
1. Understand the role of computer in design, modeling and manufacturing industry.
2. Understand basic concepts of CIM system.
3. Understand the various automated manufacturing activities
4 Apply computer Technology in the Manufacturing activities
5. Learn the smooth transition from conventional manufacturing to automated production and computer integrated manufacturing

Outcomes: After learning this subject, the student will be able to:
1. Apply geometric modeling principles to design a component
2. Use different transformation methods to solve problems in CAD
3 Appreciate the role of computers in manufacturing process and apply it in operation.
4. Combine different concepts to describe computer integrated manufacturing
5. Group similar parts and design FMS process

Unit I: Computer Graphics [7]

CAD cycle for product design, CAD workstations - data communications - input/output devices, display technology, CAD software. Transformation- Introduction, Formulation, Translation, Rotation, Scaling, Reflection, Homogenous Representation, Concatenated Transformation, Mapping of Geometric Models, Inverse Transformations.

Unit II: Geometric Modelling [7]

Requirements of geometric modeling, geometric models, Wireframe modeling, Surface modeling, geometric construction methods, constraint based modeling, Representation of curves and surfaces. Analytic curves- Lines, circles, circular arcs, ellipse, parabola, hyperbola etc. Synthetic curves - cubic splines, bezier curves, B-spline curve etc., Surface modeling –Representation of surfaces, analytical and synthetic surfaces. Solid modeling – Solid entities, methods of solid modeling

Unit III: Computer Integrated Manufacturing (CIM) and Rapid Prototyping [7]

Computer application in manufacturing automation, Computer aided inspection and quality control. Computer integrated production management system, inventory, material requirement planning, manufacturing resource planning, enterprise resource planning. Rapid Product Development and Manufacture, Extended Enterprises. Methods of rapid prototyping: steriolithography, Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), selective laser sintering, solid ground curing, 3D Printing system, Thermo jet Process, Ballistic Particle Manufacturing. Application of rapid tooling methods to press tool manufacture

Unit IV: Computer Aided Manufacturing (CAM) [7]

Concepts and features of NC, CNC & DNC - feed back devices ,Interpolators., Point-to-point and contouring systems – Interchangeable tooling system – preset & qualified tools – ISO specification – Machining center – Turning center ,
CNC Programming:- Machine Tool Co-ordinate System, Machine zero, Job zero, Cutter Programming, Tool Offsets, Manual part programming – steps involved – G-codes and M-codes, sample program in lathe & milling. CAM package – canned cycles - Programming.

Unit V: Computer Applications in Engineering Analysis [7]

Introduction, steps in FEA, Boundary conditions Co-ordinates and shape functions, Potential Energy Approach, Galerkin Approach, Assembly of Global Stiffness Matrix and Load Vector, Finite Element equations. Truss problems: Plane trusses, Three-dimensional trusses, Two dimensional problems: Finite element modeling, constant strain triangle, One Dimensional Problem and Two dimensional Problems and Boundary conditions.

Unit VI: Flexible Manufacturing System [7]

Part families – visual – parts classification and coding – case studies in coding – Production flow analysis – benefits of G.T. – Application of G.T. Cellular Manufacturing –Machine cell design – Key machine concept - quantitative analysis in cellular manufacturing – Rank order clustering technique – Arranging machines in G.T. Cell

FMS – Types of FMS – FMS components – Workstations, Material Handling and storage system – FMS Layout type, computer control system, Human resource – FMS application and benefits – FMS planning and implementation issues. Quantitative analysis of FMS – CANQ, deterministic models.

Text Books:

1. Radhakrishnan.P, Subramanyan.S and Raju.V, "CAD/CAM/CIM", New Age International Publishers, 2000,ISBN:81-224-1248-3
2. Groover and Zimmers, "CAD / CAM: Computer Aided Design and Manufacturing", Prentice Hall of India, New Delhi (1994), ISBN:81-203-0402-0.
3. Zeid Ibrahim, "CAD - CAM Theory and Practice", Tata McGraw Hill Publishing Co. LtdNew Delhi.(2000)ISBN:0-07-463991-4.
4. Kundra T.K., Rao P.N., Tiwari N.K., "Numerical control and Computer aided manufacturing", Tata McGraw Hill 1992New Delhi, ISBN:9780074517406.
5. Rao P.N,"CAD - CAM Principles and Practice", Tata McGraw Hill Publishing Co. Ltd New Delhi.(2000)ISBN:0-07-044530-3.

Reference Books:

1. James A.Retrg and Henry W. Kraebher, "Computer Integrated Manufacturing", Pearson Education, Asia, 2001
2. Viswamathan.N and Narahari.Y, "Performance Modelling of Automated Manufacturing System", Prentice Hall of India Private Limited, ISBN:978-81-203-0870-1,Reprint2009
3. Chandrupatla T.R., Belegundu A.D., "Introduction to Finite Elements in Engineering",Prentice Hall of India 2003.ISBN:13:9780130615916.

411092: Industrial Robotics

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

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Pre-requisites:

Basic knowledge of Engineering drawing, Theory of Machines, Mechanics of Materials, Design of Machine Elements, Kinematics of Manufacturing Machines

Course objectives:

- To introduce basic concepts of Robotic arm, body and wrist motions.
- To learn the concept of Direct Kinematics and Inverse kinematics.
- To understand various ways to design mechanical grippers.
- To study sensors and use of machine vision system of robotics.
- To understand control units and drives, Artificial intelligence.
- To study the advancement in robotics area.

Outcomes:

After learning this subject, the student will:

- Understand the motions of robotic arm and body which generates robot configuration.
- Apply the techniques like Homogeneous transformation to understand direct and inverse kinematics.
- Use design procedure for mechanical grippers depending upon their types and mechanism.
- Understand different types of sensors and will be able to convert blank and white image from the given gray scale pattern.
- Use different programming languages used to operate robot.
- Identify application of robots in different areas where they will work in future.

Unit 1: Fundamentals of robotics [7]

Automation and robotics, robot anatomy, historical development of industrial Robots and manipulators, basic structure of robots, resolution, accuracy and repeatability. Classification, Configuration of robots, arm and body motions, wrist motions. Robot Drives, Basic Control systems. End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

Unit II: Robot Arm Kinematics [7]

Robot kinematics-Types- 2D, 3D Transformation, D-H Representation & Displacement Matrices for Standard Configurations, Forward kinematics and Inverse kinematics analysis of manipulators with two and three degrees of freedom (planar).

Unit III: Robot Arm Dynamics [7]

Robot dynamics – Rigid body dynamics, Newton-Euler formation, Lagrange-Euler, formation, generalized D'Alembert equations of motion.

Unit IV: Sensors and Machine vision systems in Robotics [7]

Sensors -functioning, types, analysis and fields of applications. Tactile sensors, temperature sensors, Variable Pressure Light Converting Sensor, High Resolution Pneumatic tactile Sensor, Slip type Sensors, Piezoelectric Contact Sensors. Remote Sensor Compliance, Range &Proximity Sensors, Electro-optical Sensors.

Vision system: Median filtering, thresholding, discretization, smoothening of binary image. Edge detection algorithm, region growing algorithm.

Unit V: Robot Programming and Robot Interfacing [7]

Robot Programming: Methods of Programming the robot, Methods of defining positions in space, Motion interpolation, branching, Textual robot programming languages. Interfacing Robots with computers. Obstacle Avoidance: Lee's Algorithm; Counter Path Defining using 'via' point, blending Technique

Unit VI: Advanced Applications of Robots [7]

Pick and place Robot, Welding Robots, Assembly and mega-assembly Robots, Walking Robots, Climbing Robots, Machine mounted Robots. Artificial Intelligence: Concept of A.I., Role of A.I. in robotics.

Text Books:

1. Deb S.R., ―Robotics‖, Tata McGraw Hill Publications, New Delhi.
2. Yoram Koren, "Robotics for Engineers", McGraw Hill Book Co.
3. Groover M.P., Weiss M., Nagel R.N., Odrey N.G., "Industrial Robotics Technology-Programming and Applications", McGraw Hill Book Co.
4. Fu K.S., Gonzalex R.C., Lee C.S.G., "Robotics Control Sensing, Vision and intelligence", McGraw Hill Book Co.

Reference Books

1. Hartenberg and Denavit, "Kinematics and Synthesis of Linkages", McGraw Hill Book Co.
2. Hall A.S., "Kinematics and Linkage Design", Prentice Hall.
3. Hirchhorn J., "Kinematics and Dynamics of Machinery", McGraw Hill Book Co.
4. Todd D.J., ―Fundamentals of Robot Technology‖, Wiley Publications
5. Paul R., ―Robots -Manipulators, Mathematics, Programming and Control‖, MIT Press.
6. Janakiraman P.A., ―Robotics and Image Processing‖, Tata McGraw Hill 1995.

411093(A): Elective III: Sustainability Engineering

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:
Knowledge of Machine tool engineering, Welding and Foundry.

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

Unit I: **Sustainability** **[7]**
Concepts related to Sustainability, Ecosystems, Biodiversity, Air and water pollution, Energy consumption, Land degradation, Global warming, Sustainable Development, the global sustainability Agenda, Green Expectations, confronting climatic change, Wake-up Conferences, The Voice of Society, Answering the call- The Green Movement

Unit II: Types and sources of solid and hazardous wastes **[7]**

Nature and hazard of pollutants: waste processing /segregation Need for waste management, Waste processing, Green processing and engineering operations, incineration, Energy recovery, a life-cycle approach, which considers the costs and benefits associated with material acquisition, transportation, production, product use, and recovery for recycling, reuse or remanufacture. Inventory management and improved operations.

UNIT III: Environment friendly Choices in Manufacturing, Operations and Logistics **[7]**

Materials for Sustainability, Materials and processes selection, Materials for the future, Materials for Recycling, Control on non-renewable material usage Component toxicity and health impact, Integrating sustainability principles.

Unit IV Techniques of Sustainability **[7]**
Conversion technologies, Innovations for reuse, bio processing technology Energy audits, Sustainable loading on ecosystems, The concept of "eco-efficiency," a measurable characteristic of products and processes, Product Life Cycle Assessment: Environmental analysis from raw materials to disposal, Matrices for sustainable design, industrial case studies.

Unit V Rules and regulations **[7]**
Overview of the cultural, political, and economic changes that are transforming the role of environmental management in the business world. Environmental Standards e.g. ISO- 14000 Environmental Legislations: Carbon Foot Print, Implications of public policy, Anti-pollution Boards Guarding Against Environmental Impact, Alternative product and process changes, manufacturing practices, Global warming and Kyoto protocol, environmental preservations. Environment and human health, Access to potable water

UNIT VI: Multi-objective Decision Making **[7]**
Considering environmental issues in operating strategy, Creating a sustainable manufacturing company Effective Hazards Mitigation Management, Role of IT, Communication Networking, Continuous sustainability awareness

programmers; Encouraging innovations in energy generation and usage economy, Sustainability Rating Schemes, Eco-labeling Programs Case Studies, human values and professional ethics

References:

1. M. K. Ghosh Roy; Sustainable Development by Ane Books Pvt. Ltd.
2. M. Karpagam, Geetha Jaikumar, Green Management, Anne Books Pvt. Ltd
3. S. P. Misra, S.N. Pandey, Essential Environmental Studies, Sheth Publishers
4. , Joseph Fiksel, Design for Environment: A Guide to Sustainable Product DevelopmentThe McGraw-Hill Companies

411093(B): Elective III: Supply Chain Management

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

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Course Objective

To help understand the importance of and major decisions in supply chain management for gaining competitive advantage.

Course Outcomes

After Successful completion of this course students will able to:

- Build and manage a competitive supply chain using strategies, models, techniques and information technology.
- Optimize supply chain network
- Plan the demand, inventory and supply

UNIT I: Introduction [7]

Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases - Supplier-Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

UNIT II: Strategic Sourcing [7]

Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.

UNIT III: Warehouse Management [7]

Stores management-stores systems and procedures-incoming materials control-stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement

UNIT IV: Supply Chain Network [7]

Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models. Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees.

UNIT V: Planning Demand, Inventory and Supply [7]

Managing supply chain cycle inventory. Uncertainty in the supply chain –- Analyzing impact of supply chain redesign on the inventory - Risk Pooling - Managing inventory for short life - cycle products -multiple item -multiple location inventory management. Pricing and Revenue Management

UNIT VI: Current Trends [7]

Supply Chain Integration - Building partnership and trust in SC Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. . SC Restructuring - SC Mapping - SC process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Agro Supply Chains.

TEXT BOOKS

1. Janat Shah, Supply Chain Management – Text and Cases, Pearson Education, 2009.
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 2007.

REFERENCES

1. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5 th Edition, 2007.
2. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill, 2005.
3. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 2005.
4. Shapiro Jeremy F, Modeling the Supply Chain, Thomson Learning, Second Reprint , 2002.
5. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, Principles of Supply Chain Management- A Balanced Approach, South-Western, Cengage Learning 2008.

411093(C): Elective III: Automobile Engineering

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 04 hours / week	Theroy: 03	In-Sem: 30 Marks End-Sem: 70 Marks

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Pre-requisites: Basic Mechanical Engineering, Theory of Machine, Basic Electrical & Electronics, Design Machine Elements.

Course Objectives:

1. Vehicle specifications, Chassis and safety.
2. Fuel Supply System & Cooling System.
3. Lubrication System and Ignition System.
4. Drive Train and Vehicle Performance.
5. Suspension and Steering System.
6. Breaking Systems and Automobile Maintenance techniques.

Outcomes:

Upon successful completion of this subject student should be able to….

1. Understand Vehicle specifications, Chassis and safety.
2. Study of Fuel Supply System & Cooling System.
3. Understand Lubrication System and Ignition System.
4. Study of Clutches and Gear Boxes.
5. Understand Suspension and Steering System.
6. Understand Breaking Systems and Automobile Maintenance techniques.

Unit-I: Introduction to Automobile Engineering & safety [7]

Automobile -history and development, classification, vehicle layout-engine location and drive arrangement, types of vehicle bodies, chassis types, constructional details, frames, sub frames, frameless vehicles, vehicle dimensions.
Vehicle safety-active, passive safety, air bags, seat belt, types of collisions-front, rear, side, vehicle interior and ergonomics safety regulations of vehicles.

Unit II: Ignition systems and Fuel supply system. [7]

Ignition System –battery, magneto and electronic ignition system, comparison, different starting system used in automobiles
Fuel supply system-S.I. Engine, carburation, Air-fuel requirements, simple carburetor & classification, Modern Carburetors (Solex & S.I carburetor). Fuel injection in S.I. engine M.P.F.I &G.D.I , C.I. engine – classification of fuel supply system-solid injection system fuel injection pump Bosch Pump and injector

Unit III: Lubrication and Cooling system [7]

Lubrication system-objective of lubrication, types of lubricants, properties and additives, types of lubrication systems-dry sum, wet sum and mist sum lubrication, crank case ventilation (Globe eye), SAE viscosity index.
Cooling system –necessity of cooling, under cooling, overcooling, types of cooling system components, working of pressurized force & thermostatic , coolant additives

Unit IV: Drive train and vehicle performance [7]

Drive train-Types of clutches, single plate, multiplate centrifugal clutches, clutch operating systems, Wet clutches, fluid coupling, clutch plate material Functions of gear box, selection of gear ratio sliding mesh, constant mesh and epicyclic gear boxes, Synchromesh devices, automatic gear boxes, torque converters, overdrive,Electro-magnetic transmission,

Automatic overdrive, Hydraulic control system for automatic transmission. Troubleshooting and diagnosis for Clutch & Gear Box Troubleshooting, latest trends in drive train of automobile

Vehicle performance- Vehicle performance parameters, various resistances to motion, rolling, air and radiant resistance, total resistance and tractive effort, variation of tractive effort with speed power required for acceleration and gradiability

Unit V: Steering system and Braking system [7]

Steering Systems-Requirements of good steering systems, steering geometry camber, steering axis inclination, included angle, scrub radius, castor, toe in, toe out, turning radius wheel balancing, steering linkages, steering gears, cornering force, slip angles under steer, over steer, types of wheels cross ply and radial tires, tubeless tires power steering

Braking systems - Types of brake systems - drum, disc, operation-mechanical, hydraulic, air brakes, servo and power braking, hand brake, ABS.

Preventive maintenance and diagnosis for Brake and Steering system.

Unit VI: Electrical Systems and Suspension System [7]

Electrical System –

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods.

Lighting System & Accessories: Insulated & earth return systems, positive & negative earth systems, electrical fuel pump, speedometer, fuel, oil & temperature gauges, horn, wiper system, trafficator, sensors and actuators, electronic control unit, traction control devices.

Suspension Systems-Objects of suspension, principles of suspension design spring and unspring mass, types of springs, torsion bars, rubber springs, shock absorbers, independent suspension air suspension, interconnected suspension, hydro pneumatic suspension, self leveling suspension, Troubleshooting and diagnosis for Suspension system.

Text Books

1. Ganesan V., "Internal Combustion Engines", Tata McGraw Hill Publishing Company Ltd, Ninth Edition, New Delhi, 1995.
2. Mathur M.L., and Sharma R. P., "A course in I.C. Engine", Dhanpat Rai Publication, Seventh Edition, New Delhi, 1999.
3. Singh Kirpal, "Automobile Engineering – Vol II", New Chand Jain", Seventh Edition, Delhi, 1996.
4. Narang G. B. S., "Automobile Engineering", S. Chand and Company Ltd, Fifth Edition, Delhi, 1995.
5. Ballancy P. L., "Internal Combustion Engines", Khanna Publishers, Third Edition, New Delhi, 1991.

Reference Books

1 Heywood: Internal combustion Engine Fundamentals, Tata McGraw-Hill
2 Domkundwar & Domkundwar : Internal combustion Engine, Dhanpat rai
3 Automobile Electrical Equipment, P. S. Kohali, Tata McGraw Hill Publishing House.
4 Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd.
5 Crouse W.H.Anglin.,Automotive Transmission and Power Trains Construction, McGraw- Hill, 1976.

411093(D): Elective III: Entrepreneurship

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

Pre-requisites: Production Management, Industrial Engineering and Quality Assurance

COURSE OBJECTIVES:

1. Understanding the dynamic role of entrepreneurship and small businesses
2. Organizing and Managing a Small Business
3. Financial Planning and Control
4. Forms of Ownership for Small Business
5. Strategic Marketing Planning
6. New Product or Service Development
7. Business Plan Creation

COURSE OUTCOMES:

After Successful completion of this course students will able to:

1. Appreciate the importance of embarking on self-employment and has developed the confidence and personal skills for the same.
2. Start a small business enterprise by liaising with different stake holders
3. Effectively manage small business enterprise.

UNIT I: Entrepreneurship [7]

Definition. growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. Government policy for small scale industry; stages in starting a small scale industry.

UNIT II: Motivation [7]

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III: Project identification [7]

Assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.

UNIT IV: Accountancy [7]

Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies.

UNIT V: Project Planning and control [7]

The financial functions cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. Profit planning and programming, planning cash flow, capital expenditure and operations. Control of financial flows, control and communication.

UNIT VI: Laws **[7]**

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act. Role of various national and state agencies which render assistance to small scale industries.

Text Books:

1) Khanka. S.S., "Entrepreneurial Development" S.Chand & Co. Ltd.,Ram Nagar, New Delhi, 2013.
2) Donald F Kuratko, " Entreprenuership – Theory, Process and Practice", 9th Edition, Cengage Learning 2014.

Reference Books

1) Forbat, John, "Entrepreneurship" New Age International.
2) Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
3) Joseph, L. Massod, "Essential of Management", Prentice Hall of India.

411093(E): Elective III: Human Resource Management

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

Pre-requisites: Industrial organization and Management

Course objectives:

1. Understand the importance of human resources and their effective management in organizations
2. Analyze the key issues related to administering the human elements such as motivation, compensation, appraisal, career planning, diversity, ethics, and training
3. Analyze the role of recruitment and selection in relation to the organization's business with demonstration of the appropriate use of job descriptions
4. Develop, analyze and apply advanced training strategies and specifications for the delivery of training programs. Describe appropriate implementation, monitoring and assessment procedures of training

Outcomes:

After learning this subject, the student will:

1. Discuss strategic plan for the human resources needed to meet organizational goals and objectives
2. Define the process of job analysis and discuss its importance as a foundation for human resource management practice
3. Compare and contrast methods used for selection and placement of human resources.
4. Describe the steps required to develop and evaluate an employee training program
5. Identify and explain the issues involved in establishing wage and compensation systems.
6. Summarize the activities involved in evaluating and managing employee performance
7. Explain how legislation impacts human resource management practice.

Unit I **[7]**

Human Resource Management: Basic Concepts, Scope, Objective, Functions, managerial Skill and Roles
Evolution And Environment: Evolution of H.R.M., Influence of Scientific Management on HRM, Influence of Labour Movement on HRM, Influence of Govt. Regulations on HRM.
Theories OF H.R.M.: Theories of Work, Fish Bone Diagram Approach to H.R.M., System Concept of H.R.M.

Unit II **[7]**

Human Resources Planning: Introduction, Strategic Considerations, Nature and Scope Of H. R. Plans, Human Resources Inventory, Human Resources Forecast, Job Analysis, Job Description, Job Specification, Job Evaluation, Employment Stability
Recruitment: Introduction, Recruitment Policy, Sources Of Recruitment, Recruitment Methods, Effectiveness Of Recruitment Programme
Selection: Scientific Selection, Selection Policy, Selection Process, Selection Tests, Interview, Work History, References, Provisional Selection, Medical/Physical Examination, Final Selection, Employment.
Placement, Induction And Socialization: Placement, Induction, Socialization, Strategies of Socialization.
Performance Appraisal And Merit Rating: Basic Concepts, Performance Standard, Appraisal Methods, Appraisal Errors, Methods of Improving Performance Appraisal, Merit Rating.

Unit III **[7]**

T**raining and Development:** Basic Concepts, Theories of Learning, Principles Of Learning, Training Policy.

Employees Training: Training Process, Identification of Training Needs, Planning Of Training Programme, Preparation Of Trainees, Implementation Of Training Performance Evaluation Of Training, Follow-Up Training

Management/Executive Development: Introduction, Objectives, Executive Development Process, T & D Techniques and Methods, Evaluation, Supervisors, Supervisory Training.

Career Development: Basic Concepts, Stages Of Career Development, Career Development Programme.

Promotion, Transfers and Separations: Promotions, Promotion Policy, Promotion Plans, Promotion Programme, Problems in Promotion, Transfers, Demotion, Separations.

Unit IV **[7]**

Wages and Salaries Administration: Basic Concepts, Theory Of Wages, Process Of Wages Payment, Job Evaluation, Wage(Pay) Structure, Wage Fixation, Wage Payment, Wages Incentive Plans, Executive Compensation Plan

Discipline and Grievances: Employees Discipline, Code Of Discipline, Role And Responsibility Of Personnel Department, Grievances.

Industrial and Labour Relations*:* Industrial Relations, International Labour Organization (I.L.O), Labour Legislation, Industrial Relations In India, Industrial Disputes/Conflicts, Workers Participation In Management (WPM), W.P.M. International Scene, Experts Committee Reports On W. P.M., W.P.M. Case Study At BHEL- Hardwar

Trade Unionism: Introduction, Theories Of Trade Unionism, Classification Of Trade Unions, Union Management Relation, Evolution Of Trade Unionism, Trade Union As An Organization, Problems Of Trade Unions, National Commission Labour

Collective Bargaining: The Concept, The Evolution, Collective Bargaining And Strike, Collective Bargaining And Union-Management Relations, Collective Bargaining And Environment, Nature And Scope, Types Of Collective Bargaining, The Process Of Collective Bargaining, Policies Of Collective Bargaining, Laws Of Collective Bargaining, Case Studies-Collectives Bargaining, Collective Bargaining- Public Sectors And Private Sectors, Committee Reports On Collective Bargaining.

Rewards and Labour Welfare: Rewards, Non-Financial Rewards, Labor Welfare In India, Benefits(Extra-Mural), Service (Intra-Mural), Case Studies

Unit V **[7]**

Theories of Human Relations and Motivation: Human Relations, Theories of Motivation, Integration of Motivation Theories

Vocational Guidance, Job Satisfaction and Morale: Vocational Guidance, Job Satisfaction, Morale.

Steps to Promote Intrinsic Motivation: The Concept, Worker Participation In Management (WPM), Management By Objectives (MBO), Organization Behavior Modification, Job Redesign, Alternative Work Schedules.

Organization Design, Structure And Development: Organization Theory, Design Consideration of Organization, Factors Influencing Contingency Organization Design, Mintzberg's Design Configuration, Organization Design-Future Trends, Organization Structure, Dynamism Of Organization, Organization Change, Organization Development.

Empowerment: Basic Concepts, Power and Behavior, Organization Politics, Organizational Climate and Culture, Innovation and Creativity, Empowering Leaderships, Holistic View Of Human Behavior, Human Capital, Empowerment, Corporate Vitality, Future of HRM

Unit VI **[7]**

Industrial Health and Safety: Industrial Health, Occupational Hazards, Occupational Diseases, Alcoholism And Drug Abuses, Absenteeism And Turn Over, Accidents, Safety Organization, cost of safety, Statutory Provisions On Safety, industrial safety products, Work Stress, Executive Stress, Personnel Research On Industrial Health. Occupational Safety and Health Administration[OSHA], Effect of environmental conditions and work design on Energy Expenditure.

The Factories Act, 1948: Introduction, Definition In The Act, Requirements Under The Act, Licensing And Registration, Health Provisions, Safety Provisions, Welfare Provisions, Working Hours , Employment Of Young Persons, Annual Leave, Accidents And Diseases, Penalties, Miscellaneous Provisions

Reference Books:

1. Nair and Nair,Personal Management and Industrial Relations, S. Chand and Company Ltd. New Delhi,ISBN81-219-1808-1
2. Garry Dessler, Human Resource Management, Pearson; 13 edition, ISBN: 0132668211
3. C. B. Mamoria, S V. Gankar, Personnel Management, Himalaya Publishing, , ISBN: 8184888082
4. Mirza Saiyadin, Human Resources Management - McGraw Hill Education; 4 edition, ISBN: 0070263639

411094(A): Elective IV: Intelligent Manufacturing System

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

Pre-requisites: Numerical techniques and optimization methods, Process Planning and Tool Selection, Industrial Engineering and Management, Production Management

Course objectives:

1. To learn statistical methods, evolutionary optimization techniques, soft computing methods, machine learning and knowledge based system.
2. Effective applications of these methods to intelligent manufacturing systems.

Course Outcomes:

After learning this subject, the student will be able to:
Implement statistical methods, evolutionary optimization techniques, soft computing methods, machine learning and knowledge based system for manufacturing system applications such as:

1. Equipment selection and layout
2. Process planning and parametric optimization
3. Cellular manufacturing
4. Robotics systems

Unit I: Introduction to artificial intelligent techniques [7]

Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, Evolutionary computation, fuzzy logic, Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, neural networks, expert systems

Unit II: Industrial planning and decision making using intelligent systems [7]

Production planning using fuzzy cognitive maps, computer aided process planning, Methods for inventory space allocation and storage processes analysis, Optimization of production costs and methods finding of the best process plan, Methods for production equipment selection and layout, Heuristic scheduling of multiple resources, Fuzzy multiple attribute decision making methods.

Unit III: Intelligent techniques for manufacturing process optimization [7]

Application of neural networks and fuzzy sets to machining and metal forming, Artificial neural network modeling of surface quality characteristics in machining processes, parametric optimization of machining processes using evolutionary optimization methods.

Unit IV: Knowledge Based Group Technology [7]

Group Technology: Models and Algorithms – Visual method, Coding method, Cluster analysis method Knowledge based group technology – Group technology in automated manufacturing system, Structure of knowledge based system for group technology (KBSGT) –database, knowledge base, Clustering algorithms

Unit V: Intelligent robotic systems [7]

Applications of intelligent systems for mobile Robot Motion Planning, Path Planning Robot Control in Dynamic Environments, Task Based Hybrid Closure Grasping Optimization for Autonomous Robot Hand. Accurate Motion Control of Fast Mobile Robots, obstacle avoidance.

Unit VI: Use of Intelligent techniques in flexible manufacturing systems (FMS) [7]

Applications of various intelligent systems for FMS functional segmentation schemes including control, real time scheduling, tool management, process planning, route optimization for AS/RS systems.

References:

1. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall , 1990
2. Badiru A.B., “Expert Systems Applications in Engineering and Manufacturing”, Prentice-Hall, New Jersey, 1992.
3. Liu, Dikai, Wang, Lingfeng, Tan, Kay Chen (Eds.) Design and Control of Intelligent Robotic Systems, Springer-Verlag, London. ISBN 978-3-540-89932-7
4. Rao R. V. “Advanced Modeling and Optimization of Manufacturing Processes”, Springer-verlag, London. ISBN 978-0-85729-014-4

411094(B): Elective IV: Energy Management

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

Pre-requisites: Basic Mechanical Engineering, Heat and Fluid Engineering

OBJECTIVES:

At the end of the course, the student is expected to

1. understand and analyze the energy data of industries
2. carryout energy accounting and balancing
3. conduct energy audit and suggest methodologies for energy savings and
4. utilize the available resources in optimal ways

Course Outcomes:

After successful completion of this course students will:

1. Identify areas of energy conservation in industries.
2. Identify role and responsibilities of an energy manager and energy auditor.
3. Analyze working of the energy utilizing and generating machines.
4. Practice and utilize the instruments in energy audit process.
5. Implement proper energy saving techniques in boiler, furnaces, compressors and heavy machineries.

Unit I: Energy Scenario [7]

Energy Scenario: Basic of energy and its various Forms, Global primary energy reserves and consumption pattern, Indian energy scenario, sector wise energy consumption(domestic, industrial and other sectors), energy needs of growing economy, energy pricing in India, Energy Security: Chemical and Nuclear, energy and its impact on environmental climatic change , importance of energy conservation and introduction of energy conservation act 2001,

Future Energy Options: Sustainable Development, Energy Crisis: Transition from carbon rich and nuclear to carbon free technologies, parameters of transition, Need for use of new and renewable energy sources.

Unit II: Energy Economics and Audit [7]

Energy economics: Simple payback period, time value of money, return on investment, net present value and internal rate of return.

Energy Audit: Role of Energy auditor and Manager, Methodology, analysis and reporting, portable and online instruments required for energy audit, Energy audit case studies (Milk Industry, Central Library of Institute, Workshop, department sankey diagram and specific energy consumption.

Unit III: Energy Efficiency and Energy Performance in Thermal utilities [7]

Boiler efficiency calculations by direct and indirect method, various losses, steam distribution and steam traps, energy conservation opportunities in boiler. Efficiency calculation of oil fired furnace, heat losses and energy conservation opportunities in furnace. Thermal insulation, types of insulation, economic thickness of insulation.

Unit IV: Electrical System [7]

Demand control, billing structure, power factor improvement, benefits and ways of improving PF, load scheduling, electric motors, losses and efficiency, energy efficient motor, speed control methods of motor, Soft starters with energy saver, Lighting: illumination level, fixtures, timers, energy efficient illumination.

Unit V: Compressed air System and HVAC system [7]

Energy conservation in: Compressed air systems, refrigeration and air conditioning systems, pumps, fans, Diesel Generator (D.G.) set, Introduction to cooling tower and its type ,Energy conservation in opportunities in Cooling tower cooling tower, Energy conservation in boiler feed water pump, pumping systems for municipal drinking water, and sewerage, agriculture pump sets

Unit VI: Cogeneration, Trigeneration and waste heat recovery [7]

Cogeneration: Concept, technical options, classification of cogeneration system i.e. topping and bottoming cycle, selection criteria, applications. Concept of Trigeneration (CCHP), Waste Heat Recovery: Introduction, classification and applications, benefits, waste heat recovery equipments i. e. recuperator, regenerator, economizer, heat wheel, heat pipe, thermo-compressor, heat pump.

Reference Books:

1. Guide books 1, 2 and 3, Bureau of Energy Efficiency.
2. Practical Energy Audit Manual, Indo –German Energy Efficient Project, Tata EnergyResearch Institute (TERI).
3. Albert Thumann, Plant Engineers and Managers Guide to Energy Conservation, CRCPress.
4. I. G. C. Dryden , The Efficient Use of Energy, IPC Science and Technology Press.
5. S. C. Tripathy, Electric Energy Utilisation and Conservation, Tata McGraw-HillPublishing Company Ltd.
6. P. H. Henderson: India- The Energy sector, Oxford University Press.
7. W. C. Turner, editor: The efficient use of energy (Butterworths)
8. Frank Keith, Yogi Goswami, “Enegy Management and End use Efficiency Handbook” Taylor and Francis.
9. Donald A. Wulfinghoff, Energy Efficiency Manual, Energy Institute Press.
10. Energy Management Principles, C.B. Smith, Pergamon Press
11. Energy Management, Trivedi. P.R., Jolka K.R., Common wealth Publication.

411094(C): Elective IV: World Class Manufacturing

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: Production Management, Industrial Engineering and Quality Assurance.

Course Objectives: To enable manufacturing enterprises to be competitive by dynamically reconfiguring software, equipment and organization structures in this era of globalization.

Course Outcomes

After successful completion of course student will able to,

- Understanding recent trends in manufacturing
- Customization of product for manufacturing
- Implementation of new technology

Unit I: Historical Perspective **[7]**

World class Excellent organizations – Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence.

Unit II: Benchmark, Bottlenecks and Best Practices **[7]**

Concepts of benchmarking, Bottleneck and best practices, Best performers – Gaining competitive edge through world class manufacturing – Value added manufacturing – Value Stream mapping - Eliminating waste –Toyota Production System –Example.

UNIT-III: System and Tools for World Class Manufacturing **[7]**

Improving Product & Process Design – Lean Production – SQC, FMS, Rapid Prototyping , Poka Yoke, 5-S ,3 M, JIT, Product Mix , Optimizing , Procurement & stores practices , Total Productive maintenance, Visual Control.

Unit IV: Human Resource Management in WCM **[7]**

Adding value to the organization– Organizational learning – techniques of removing Root cause of problems–People as problem solvers–New organizational structures. Associates–Facilitators– Teamsmanship–Motivation and reward in the age of continuous improvement.

Unit V: Typical Characteristics of WCM Companies **[7]**

Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –Six Sigma philosophy

Unit VI: Indian Scenario **[7]**

Case studies on leading Indian companies towards world class manufacturing –Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing

Text Books

1. Sahay B.S., Saxena KBC. and Ashish Kumar, "World Class Manufacturing – Strategic Perspective, Mac Milan Publications, New Delhi.
2. Korgaonkar M.G., "Just In Time Manufacturing", MacMilan Publications
3. Narayanan V.K., "Managing Technology and Innovation for Competitive Advantage",Prentice Hall, 2000

References:

1. Adam and Ebert, “Production and Operational Management”, 5th Edition, Prentice Hall learning pvt. Ltd., New Delhi.
2. Ron Moore, “Making Common Sense Common Practice – Models for manufacturingexcellence”, Butter worth Heinmann
3. Jeffrey K.Liker, “The Toyota Way – 14 Management Principles”, Mc-Graw Hill, 2003.
4. Chase Richard B., Jacob Robert., Operations Management for Competitive Advantage”,11th Edition, McGraw Hill Publications, 2005.
5. Moore Ron, “Making Common Sense Common Practice”, Butterworth-Heinemann, 2002.
6. Womack J.P., Jones D.T., “Machine That Changed The World: The Story ofLeanProduction”, Harper Perennial, 1991.

411094(D): Elective IV: Finite Element Analysis

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

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

Course Objective:

1) To provide the knowledge about Finite element method.
2) To aware the students about programming of force analysis of mechanical components and structures.
3) To provide knowledge about the heat transfer analysis of component.
4) To aware the students about recent software's used in simulation and analysis.

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 [7]

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 [7]

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 [7]

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 [7]

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 [7]

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

Unit VI: Dynamic analysis **[7]**

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

Reference Books

1. Chandrupatla T. R. and Belegunda A. D., ―Introduction to Finite Elements in Engineering‖, Prentice Hall India.
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.

411094(E): Elective IV: Environmental Engineering

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

Pre-requisites: Basic knowledge of Chemistry and Physics, Basic knowledge of environment and its composition

OBJECTIVES:

To impart knowledge of environment and different types of pollution
To impart knowledge about causes and preventive measures against air pollution
To impart knowledge about causes and preventive measures against water pollution
To impart knowledge about causes and preventive measures against noise pollution

Course Outcomes:

After successful completion of this course students will be able to,

1. Understand importance of environment and different types of pollution
2. Explain causes and preventive measures against air pollution.
3. Describe causes and preventive measures against water pollution.
4. Explain causes and preventive measures against noise pollution.

Unit I: Introduction to Air Pollution [7]

Man and Environment: Overview (socio-economic structure & occupational exposures) – Scope of Environmental Engineering – pollution problems due to urbanization & industrialization

Air Pollution: Causes of air pollution – types & sources of air pollutants- Climatic & Meteorological effect on air pollution concentration- formation of smog and fumigation

Analysis of Air Pollutants: Collection of Gaseous Air Pollutants- Collection of Particulate Pollutants – Analysis of Air Pollutants like: Sulphur dioxide – Nitrogen oxide – Carbon monoxide – Oxidants &Ozone – Hydrocarbons – Particulate Matter

Unit II: Methods &Approach of Air Pollution Control [7]

Air Pollution Control Measures & Equipment, Controlling smoke nuisance – Develop air quality criteria and practical emission standards – Creating zones suitable for industry based on micrometeorology of air area – Introducing artificial methods of removal of particulate and matters of waste before discharging to open atmosphere

Unit III: Water and Environment [7]

Water Sources Origin of waste water – Types of water pollutants and their effects

Different Sources of Water Pollution: Biological Pollution (point & non-point sources) – Chemical Pollutants: Toxic Organic & Inorganic Chemicals – Oxygen demanding substances – Physical Pollutants: Thermal Waste – Radioactive waste – Physiological Pollutants: Taste affecting substances – other forming substances

Unit IV: Water Pollution & Its Control [7]

Adverse effects on: Human Health & Environment, Aquatic life, Animal life, Plant life — Water Pollution Measurement Techniques – Water Pollution Control Equipment& Instruments – Indian Standards for Water Pollution Control

Unit V: Soil and Environment [7]

Liquid & Solid Wastes – Domestic & Industrial Wastes – Pesticides – Toxic: Inorganic & Organic Pollutants – Soil Deterioration – Poor Fertility, Septicity, Ground Water Pollution, Concentration of Infecting Agents in Soil

Solid Waste Disposal: Dumping domestic & Industrial Solid Wastes: Advantages & Disadvantages – Incineration: Advantages & Disadvantages – Sanitary Land Field: Advantages & Disadvantages – Management of Careful & Sanitary Disposal of Solid Wastes

Unit VI: Noise and Environmental Management System [7]

Noise Pollution & Control: Noise Pollution: Intensity, Duration – Types of Industrial Noise – Ill effects of Noise – Noise Measuring & Control – Permissible Noise Limits

Environmental Legislations, Authorities & Systems: Air & Water Pollution Control Acts & Rules (Salient Features only) – Functions of State / Central Pollution Control Boards – Environmental Management System: ISO 14 000 (Salient Features only

Reference Books:

1. Culp, G., George, W., Williams, R. and Mark, Hughes, V.Jr. "Wastewater Reuse and Recycling Technology-Pollution Technology" Review-72, Noyes Data Corporation, New Jersey
2. Pandey, G.N. and Corney, G.C. "Environmental Engineering", Tata Mc-Graw Hill.
3. Shen, T.T. "Industrial Pollution Prevention Handbook", Springer-Verlag.
4. D.lal, A.K.Upadhyay , "Water Supply and Waste Water Engineering", KATSON Books
5. Nancy, J.S. "Industrial Pollution Control: Issues and Techniques", Van Nostrand Reinhold.
6. Sivakumar, R. "Introduction to Environmental Science & Engineering'', Mc-Graw Hill.
7. Arya, S.P. "Air Pollution Meteorology and Dispersion", Oxford University Press
8. Rao, M. & Rao, H.V.N. "Air Pollution'', Mc-Graw Hill.
9. Davis, M. &Masten, S. "Principles of Environmental Engineering and Science'', McGraw Hill.

411095: Computer Integrated Design & Manufacturing Lab

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

The term work shall consist of assignments based on the following topics. Evaluation of practical will be based on Oral examination.

1. Construction of parametric solid model of any machine elements using software package.
2. Programming on CNC Lathe/Milling (student must perform one job in group of 5 students)
3. Stress–strain analysis of any machine component consisting of 1-D, 2-D elements using FEA software.
4. Simulation of a simple mechanical system

411096: Industrial Robotics Lab

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

Term Work

The term work shall be based on the following Practical Sessions (Any 6 from 1 to 7, 8 is compulsory)

1 Experiment on Robot configuration.
2 Experiment on Robot forward kinematic analysis
3 Experiment on Robot inverse kinematic analysis
4 Programming the robot for pick and place operation using any robot
5 Robot Programming for Color identification/shape identification/path tracking
6 Selection of gripper & sensors for any one application
7 Detail report on any one standard configuration viz. PUMA, SCARA, Stanford etc.
8 Industrial visit and its report on industrial applications of robots

411097(A): Elective III: Sustainability Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

The term work shall be based on the following Practical Sessions

1. Assignment on overview of sustainable manufacturing.
2. Assignment on waste management
3. Assignment on environment friendly materials for sustainable product
4. Assignment on Product Life Cycle Assessment of any product of choice: Environmental analysis from raw materials to disposal (separate for each student)
5. Assignment on Environmental Standards e.g. ISO- 14000 Environmental Legislations
6. Industrial visit report of in any Industry.

411097(B): Elective III: Supply Chain Management Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work will be based on one assignment on each unit and any two case studies are to be prepared separately by every project group.

1. Case study on Supplier selection.
2. Case study on Logistics management.
3. Case study on Supply Chain Management

411097(C): Elective III: Automobile Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

The term work shall be based on of the following assignments (Any Seven)

1. Study of fuel injection systems for SI and CI engines.
2. Study and demonstration of cooling systems in an automobile.
3. Study of ignition systems in an automobile.
4. Study and Demonstration of different types of clutches.
5. Study and demonstration of transmission system in an automobile.
6. Study and Demonstration of different types braking system.
7. Study and Demonstration of suspension system.
8. Study of preventive maintenance, trouble shooting for clutch, steering, brake, suspension and gear box systems in an automobile
9. Visit to Service Station to study computerized wheel alignment.
10. To study and prepare report on the constructional details, working principles and operation of the Electric Vehicle
11. To study of Automotive Emission / Pollution control systems.

411097(D): Elective III: Entrepreneurship Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

1. Term work will be based on one assignment on each unit.
2. A small scale business plan is to be prepared using the topics covered.

411097(E): Elective III: Human Resource and Management Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work shall consist of Assignment And/Or Case studies based on each unit

411098(A): Elective IV: Intelligent Manufacturing System Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work will be based on following assignments:

1. Study of Artificial Intelligent techniques with application examples
2. Case studies on industrial decision making using fuzzy multiple attribute decision making
3. Applications of artificial neural networks to manufacturing engineering
4. Study of various clustering algorithms for group technology
5. Study of algorithms for robot path planning/obstacle avoidance
6. Case study on route optimization of AS/RS systems.

411098(B): Elective IV: Energy Management Lab

Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work will be based on following assignments (any Six)

1. To study of global primary and Indian energy reserves and consumption pattern
2. To Study of future energy options
3. To study of investment analysis tools relevant to energy management projects
4. Case study of energy audit on Milk Industry/Central Library of Institute/ Workshop/ any other firm
5. Case study on energy conservation opportunities in boiler/furnace.
6. To study of conservation opportunity in HVAC System
7. To study of lightening system for energy conservation
8. To study of Cogeneration, Trigeneration (CCHP) System
9. To Study of waste heat recovery equipments

411098(C): Elective IV: World Class Manufacturing Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term Work shall consist of Assignment/Case studies based on each unit.

411098(D): Elective IV: Finite Element Analysis Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 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

411098(E): Elective IV: Environmental Engineering Lab

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 02 hours / week	Pr/Or: 01	Termwork: 50 Marks

Term work shall consist of following Practical's (any Seven)

1. Ambient air quality monitoring for PM10/PM2.5,SO_2 & NO_x
2. pH and Alkalinity of raw water, soft drinks & tea.
3. Total hardness and components of raw water.
4. Most Probable Number (MPN) Determination
5. Measure mineral and phenolphthalein acidity
6. Measure Fluorides or Iron contents in water
7. To determine the acidity of various water samples
8. Measurement of noise levels at various locations using sound level meter, Calculate cumulative noise level at any one location.
9. Site visit to water treatment plant and Detailed Report
10. To Study air and water control acts and rules

411099: Project Work

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 06 hours / week	Pr/Or: 06 (TW:01 and Oral:05)	Termwork: 50 Marks Oral: 100 Marks

A per submitted project phase II plan to complete it within the time schedule, the term work shall consist of:

1. **Fabrication of models, machines, prototypes based on new ideas, robots and machine based on hi-tech systems and automation, experimental set-up, fabrication of testing equipment, renovation of machines, etc. Above work shall be taken up individually or in groups**.

OR

Extensive analysis of some problems done with the help of a computer individually or in a group not exceeding two students.

2. A detailed report on the work done shall include project specification, design procedure, drawings, process sheets, assembly procedure and test results etc. Project may be of the following types:

i. Manufacturing / Fabrication of a prototype machine' including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation.
ii. Improvement of existing machine / equipment / process.
iii. Design and fabrication of Jigs and Fixtures, dies, tools, special purpose equipment, inspection gauges, measuring instruments for machine tools.
iv. Computer aided design, analysis *of* components such as stress analysis.
v. Problems related to Productivity improvements/Value Engineering/Material Handling Systems
vi. Energy Audit of an organization, Industrial evaluation of machine devices.
vii. Design of a test rig for performance evaluation of machine devices.
viii. Product design and development.
ix. Analysis, evaluation and experimental verification of any engineering problem encountered.
x. Quality systems and management. Total Quality Management.
xi. Quality improvements, In-process Inspection, Online gauging.
xii. Low cost automation, Computer Aided Automation in Manufacturing.
xiii. Time and Motion study, Job evaluation and Merit rating
xiv. Ergonomics and safety aspects under industrial environment
xv. Management Information System.
xvi. Market Analysis in conjunction with Production Planning and Control.

OR

Computer based design / analysis or modeling / simulation of product(s), mechanism(s) or system (s) and its validation or comparison with available benchmarks / results. When a group of students is doing a project, names of all the students shall be included on every certified report copy.

Two copies of Final Project Report shall be submitted to the college. The students shall present their Final Project Phase-II report. Before the examiners. The oral examination, shall be based on the term work submitted and jointly conducted by an internal and external examiner from industry, at the end of second semester.

Format of the project report should be as follows:

1 Paper: The Project report should be typed/printed on white paper of A-4 size.

2 Typing: The typing shall be with one and half spacing and on one side of the paper.

3 Binding: The Industrial Implant Report should be submitted with front and back cover in black Hard bound, with golden embossing.

4 Margins: Left -1.25", Right -1". Top and Bottom 1"

5 Sequence of Pages:

5.1 Title page
5.2 Certificate form Institute
5.3 Completion Certificate form Industry, if sponsored.
5.4 Acknowledgement
5.5 Abstract
5.6 Index
5.7 Nomenclature and Symbols
5.8 Actual Content
5.9 Conclusion
5.10 References.

6. Front cover: The front cover shall have the following details in block capitals

i. Title at the top.

ii. Name of the candidate in the centre, and

iii. Name of the Institute, Name of Industry, if sponsored and the year of submission on separate lines, at the bottom.

1 Blank sheets: No blank sheets be left anywhere in the report.

2 Project Completion Certificate: The approval sheet follows the title sheet and shall be as shown with proper spacing. CERTIFICATE This is to certify that Mr. /Ms ……(Name)……has carried out a Project entitled, ……during the course of his training at……..in partial fulfillment of the requirement of the

B.E. Production Engineering Course of University of Pune at ……during the academic Year ……

Date: (Guide) Place:

(Examiner) (Head of Department)

Syllabus

Savitribai Phule Pune University

Faculty of Engineering

Common for

Second Year Production Engineering

and

Second Year Industrial Engineering

(Course 2015)

(with effect from June 2016)

Savitribai Phule Pune University, Pune
Syllabus Common for Second Year Production Engineering and Industrial Engineering (2015 Course)
(With effect from Academic Year 2016-17)

Semester- I

Course Code	Course	Teaching Scheme (Hrs/week)			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
207002	Engineering Mathematics III	4		1	50	50	25			125	5	
211101	Heat and Fluid Engineering	4			50	50				100	4	
211102	Mechanics of Materials	4			50	50				100	4	
211103	Welding and Foundry	4			50	50				100	4	
211104	Material Science	3			50	50				100	3	
211105	Heat and Fluid Engineering Lab		2				25			25		1
211106	Welding and Foundry Lab		2					50		50		1
211107	Material Science Lab		2					50		50		1
211108	Machine Drawing & Computer Graphics Lab		4				50	50		100		2
											20	**5**
211109	Audit Course 1										**Grade:**	
Total		**19**	**10**	**1**	**250**	**250**	**100**	**150**		**750**	**25**	

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TUT: Tutorial
PR: Practical
AP: Audit Course Pass

Semester- II

Course Code	Course	Teaching Scheme			Examination Scheme						Credit	
		Theory	Practical	Tutorial	Paper		TW	OR	PR	Total	TH/TW/TUT	PR/OR
					In-Sem	End-Sem						
203050	Electrical Technology	4			50	50				100	4	
211110	Theory of Machines	4			50	50				100	4	
211111	Machine Tool Operations	4			50	50				100	4	
211112	Design of Machine Elements	4			50	50				100	4	
211113	Engineering Metallurgy	4			50	50				100	4	
203051	Electrical Technology Lab		2				50			50		1
211114	Theory of Machines Lab		2				25	50		75		1
211115	Engineering Metallurgy Lab		2					50		50		1
211116	Production Practice I		2					50		50		1
211117	Soft skills		2				25			25		1
											20	**5**
211118	Audit Course 2										**Grade:**	
	Total	**20**	**10**		**250**	**250**	**100**	**150**	**-**	**750**	**25**	

Abbreviations:

TW: Term Work
TH: Theory
OR: Oral
TUT: Tutorial
PR: Practical
AP: Audit Course Pass

207002: Engineering Mathematics III (Mechanical + SW / Production + SW / Industrial /Automobile Engineering)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 4 hours / week	Theory: 04	In-Sem: 50 Marks
Tutorials: 1 Hr/week	Tutorial: 01	End-Sem : 50 Marks
		Term work: 25 Marks

Prerequisites: Differential and Integral Calculus, Taylor series and Infinite series, Differential equations of first order and first degree, Fourier series, Measures of central tendency and dispersion, Vector algebra

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of mathematical principles related to:

- Ordinary and partial differential equations applied to Mechanical engineering problems such as mechanical vibrations and heat transfer.
- Integral Transform techniques such as Laplace transform, Fourier transform and applications to ordinary and partial differential equations in Vibration theory, Fluid dynamics, Heat transfer and Thermodynamics.
- Statistical methods such as correlation, regression analysis and probability theory in analyzing and interpreting experimental data applicable to Reliability engineering
- Vector differentiation and integration applied to problems in Fluid Mechanics.

Course Outcomes:

At the end of this course, students will be able to:

1) Solve higher order linear differential equations and apply to modeling and analyzing mass spring systems.
2) Apply Laplace transform and Fourier transform techniques to solve differential equations involved in Vibration theory, Heat transfer and related engineering applications.
3) Apply statistical methods like correlation, regression analysis in analyzing, interpreting experimental data and probability theory in testing and quality control.
4) Perform vector differentiation and integration, analyze the vector fields and apply to fluid flow problems.
5) Solve various partial differential equations such as wave equation, one and two dimensional heat flow equations.

Unit I
Linear Differential Equations (LDE) and Applications (9)

LDE of nth order with constant coefficients, Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous & Symmetric simultaneous DE. Modeling of mass-spring systems, free and forced damped and undamped systems.

Unit II (9)
Transforms
Laplace Transform (LT): LT of standard functions, properties and theorems, Inverse LT, Application of LT to solve LDE.

Fourier Transform (FT): Fourier integral theorem, Fourier transform, Fourier Sine & Cosine transform, Inverse Fourier Transforms.

Unit III (9)
Statistics and Probability

Measure of central tendency, Standard deviation, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Probability, Probability distributions: Binomial, Poisson and Normal distributions, Population and sample, Sampling distributions, t-distribution, Chi-square distribution.

Unit IV
Vector Differential Calculus

Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.

Unit V (9)
Vector Integral Calculus and Applications

Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Fluid Mechanics, Continuity equations, Streamlines, Equations of motion, Bernoulli's equation.

Unit VI
Applications of Partial Differential Equations (PDE) (9)

Basic concepts, modeling of Vibrating String, Wave equation, one and two dimensional Heat flow equations, method of separation of variables, use of Fourier series. Solution of Heat equation by Fourier Transforms, Two-dimensional wave equation.

Text Books:

1. Advanced Engineering Mathematics, 9e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).

Reference Books:

1. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
2. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
3. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
4. Applied Mathematics (Volumes I and II) by P. N. Wartikar& J. N. Wartikar (Pune Vidyarthi

Griha Prakashan, Pune).
5. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
6. Advanced Engineering Mathematics with MATLAB, 2e, by Thomas L. Harman, James Dabney and Norman Richert (Brooks/Cole, Thomson Learning).

Guidelines for Tutorial and Term Work:

i) Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
ii) Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.

Heat and Fluid Engineering

211101

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online):50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Basic Mechanical Engineering, Physics

Course objectives:

- Understand the concept of fluid along with its different properties and pressure measurement
- Development of ability in students to identify types of flow, various losses during flow of fluid
- Acquiring knowledge of different types of fuels and their analysis, steam and its properties, refrigeration system and properties of air
- Understanding the basics of compressors, engines, turbines, pumps, compressors, boiler, and refrigerators.

Outcomes:

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

- Understand the basic principles and laws of fluid mechanics to recognize and analyze the type of fluid and fluid flow along with its application.
- Develop the understanding of basic pressure measurement and its application in throughout fluid mechanics.
- Analyze boiler and energy balance concept. Also understand the properties and behavior of steam and different types of fuels.
- Understand basic working principle and application of Vapour compression cycle, turbines and compressor and analyze its performance characteristics.
- Perform individually or in a group to formulate and solve the engineering problem and to conclude the result of the outcome.

Unit I **(8)**

Introduction & Fluid properties

Definition of fluid, Newton's law of Viscosity, classification of fluid: Newtonian & Non -Newtonian fluids, Ideal & Real fluids, Fluid properties: viscosity, compressibility, cohesion, adhesion, surface tension, capillarity, vapour pressure, cavitations. (Numerical)

Static's of Fluid, Pascal's law, Pressure on plane/curved surface, pressure measurements, Manometers, centre of pressure, metacentric height.

Unit II **(8)**

Fluid Flow

Types of flow, examples, forces acting on fluid flow, Stream lines, Path lines, Streak lines. Velocity potential, Euler's equation of motion along a stream line, Bernoulli's equation, applications of Bernoulli's equation, orifice meter, venturimeter, Pitot tube (Numerical)

Unit III (8)

Losses through pipes

Flow through pipes ,Laminar and turbulent flow through circular pipes, major loss-Darcy-Weisbach equation, minor losses, , water hammer, Buckingham's pie theorem, dimensionless numbers Fluid Machinery, Construction, working and applications of hydraulic turbines, centrifugal pumps and reciprocating pumps.

Unit IV (8)

Fuels and lubricants

Mass function, combustion equation, proximate and ultimate analysis of fuel, stoichiometric analysis of combustion products, volumetric and gravimetric analysis, types & properties of lubricants, flash point, fire point, viscosity, Vapour pressure

Steam generators: Steam generation, steam properties, Babcock and Wilcox boiler, Cochran boilers (construction and working), boiler accessories, boiler performance, boiler efficiency, equivalent of evaporation and energy balance. (Numerical)

Unit V (8)

Refrigeration

Air refrigeration, vapour compression refrigeration system, various refrigerants used in refrigeration systems, their effect on environment

Air conditioning

Psychometry, properties of air, types of air conditioning, central, unit and industrial air conditioning, introduction to HVSC.

Heat transfer- Applications of conduction, convection and radiation in manufacturing.

Unit VI (8)

Reciprocating compressor: FAD, work done, efficiency-volumetric (with clearance volume), isothermal, multistage compression (Numerical)

IC engines: Cycle diagram, diesel and Otto cycle (no numerical) IC engine systems --starting, ignition, cooling and lubrication systems, testing and performance of IC engine (Numerical)

Text Books

1. Bansal R.K., "Fluid Mechanics and Hydraulic Machines", 9th Edition, Laxmi Publication, 1990, ISBN 81-7008-311-7.
2. Jain A.K., "Fluid Mechanics including Hydraulic Machines", Khanna Publishers, 1990, ISBN 81-7409-194-7.
3. Munson, Young, Okiishi and Huebsch, "Fundamentals of Fluid Mechanics, Sixth Edition, Wiley – India Edition, 2010.
4. Kumar A., "Thermal Engineering", Narosa Publishing House, ISBN 97-88-1731-95281

Reference Books

1. Kothanaraman C. P., Khajuria P. P., Arora S. and Domkundawar S, "A course inThermodynamics and heat engines (Thermal engineering with solar energy)", 3ed.,DhanpatRai & sons, 1989.
2. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 1987.
3. Deshpande V. M., "Hydraulics Machinery Textbook of Fluid Machinery", Everest Publication, 1998.
4. Khurmi R. S. and Gupta J. K., "Textbook of Refrigeration and Air Conditioning", S. Chand and Co.

Mechanics of Materials

211102

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online):50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Engineering Mechanics, Physics

Course objectives:

- To provide basic knowledge in mechanics of materials so that the students can solve real engineering problems and design engineering systems.
- To establish an understanding of the fundamental concepts of mechanics of deformable solids; including static equilibrium, geometry of deformation, and material constitutive behavior.
- To discuss the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear, and combined loading.
- To build the necessary theoretical background for further structural analysis and design courses.

Course Outcomes:

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

- Understand the concepts of stress and strain at a point as well as the stress-strain relationship for homogeneous, isotropic materials.
- Understand the analysis and design the members subjected to tension, compression, torsion, bending and combined stresses using fundamental concepts of stress, strain and elastic behavior of materials.
- Understand the procedure of determining the stresses and strains in members subjected to combined loading and apply the theories of failure for static loading.
- Understand analysis of slender, long columns and determine and illustrate principal stresses, maximum shearing stress and stresses acting on a structural member.

Unit I **(8)**

Simple stresses and strains:
Basic Concept of stress and strain (linear, lateral. shear and volumetric), Hooke's law, Poisson's ratio, modulus of elasticity, modulus of rigidity, stress strain diagrams for ductile and brittle materials, factor; of safety, working stress, generalized Hooke's law, concept of 3-D stress state, bulk modulus, interrelation between elastic constants**.**

Unit II **(8)**

Axially Loaded Components
Axial force diagram, stresses, strains, strains & deformations in determinate and indeterminate, homogenous and composite bars under concentrated loads, self-weight and temperature changes.

Transversely Loaded Components

Shear Force and Bending Moment in Determinate Beams due to Concentrated Loads, Uniformly Distributed Loads. Relation between SF and BM Diagrams for Cantilevers, Simple and Compound Beams, Bends Defining Critical and Maximum Values and Positions of Points of Contra Flexure-Construction of Loading Diagram and BMD from SFD and Construction of Loading Diagram and SFD from BMD.

Unit III **(8)**

Bending stresses

Theory of simple bending, assumptions, derivation of flexure formula, second moment of area of common cross sections with respect to centroidal and parallel axes. bending stress

Shear stresses:

Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress, shear connection between flange and web.

Unit IV **(8)**

Transformation of Stresses and Strains

Normal and shear stresses on any oblique plane. Concept of principal planes. Derivation of expressions for principal stresses and maximum shear stress, position of principal planes and planes of maximum shear, graphical solution using Mohr's circle of stresses.

Strain energy and impact

Concept of strain energy, derivation and use of expressions for deformations of axially loaded members under gradual impact loads. Strain energy due to self-weight.

Unit V **(8)**

Torsion of circular shafts:

Stresses, strains and deformations in determinate and indeterminate shafts of solid and hollow homogeneous and composite circular cross section subjected to twisting moment. Derivation of torsion equation. Stresses due to combined torsion, bending and axial force on shafts.

Cylinders and spherical shells

Thin and thick cylinders, thin spheres, volumetric strains, pre-stress in cylinders, cylinders under combined loading, compound cylinders analysis, spherical shells analysis.

Unit VI **(8)**

Slope and deflection of Beams:

Relation between BM and slope, slope and deflection of determinate beams, Double Integration Method (Macaulay's Method).Derivation of Formulae for Slope and Deflection for Standard Cases.

Buckling

Concept of buckling of columns. Derivation of Euler's formula for buckling load for column with hinged ends. Concept of equivalent length for various end conditions. Limitations of Euler's formula. Rankin's formula. Johnson's formula, safe load on columns.

Reference Books

1. Ramamrutham S. and Narayanan R., "Strength of Materials", Dhanapat Rai and sons,1992, ISBN: 818743354X

2. Rao Prakash “Strength Of Materials- A Practical Approach”, Vol I, Universities Press India Limited, ISBN: 8173711259
3. Rattan S. S., “Strength of Materials”, Tata McGraw-Hill Education,2011, ISBN: 007107256X
4. Junnarkar and Shah H J., “Mechanics of Structures”, Charotar Press, 2002, ISBN: 81-85594-06-6.
5. Rajput R. K., “Strength of Materials”, S. Chand Publication. ISBN-10 : 8188458104
6. Khurmi R. S., “Strength of Materials”, S. Chand Publication., ISBN:8121928222
7. Beer F. P., Johnston E. R and Dewolf J. T., “Mechanics of Materials”, McGraw Hill Higher Education, 5th edition, 2004, ISBN: 978-007 3529 387.
8. Gere J. M. and Timoshenko S. P., “Mechanics of Materials”, 4th Edition, PWS Pub. Co, 2001, ISBN 978-0534934293.
9. Popov E. P., “Engineering Mechanics of Solids”, Prentice Hall of India LTD, New Delhi, 2008.ISBN-10 :0137261594
10. Singer and Pytel, “Strength of Materials”, Addison Wesley Publishing Corporation, 1999, ISBN 0 321 04541 6.
11. Timoshenko S P. and Young D. N., “Strength of Materials”, Affiliated East-West Press PVT. LTD. New Delhi, 2006, ISBN : 8176710199

Welding and Foundry

211103

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online):50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Basic Mechanical Engineering, Physics

Course objectives:

- To study on different types of welding processes practiced in industry
- To understand the weld joint design, physics of welding and Symbols
- To provide basic understanding of foundry practices and processes

Course Outcomes:

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

- Classify and describe welding processes.
- Predict safety measures, inspection and testing of welding of welding.
- Describe and classify metal casting process and casting defects.
- Justify the pattern material, allowances, and effect of mould ingredients on mould strength.
- Design the gating system and risers.

Unit I **(8)**

Introduction & classification of welding processes, Basic electrical – Electrodes – coding of electrodes – Electrode efficiency, Welding symbol. Physics of welding – arc structure, characteristics and power – chemical heat source- contact resistance heat source- heat flow characteristics- cooling of weld.

Arc welding processes- carbon arc, submerged arc, Tungsten inert gas (TIG), Metal Inert gas (MIG), Plasma arc, stud welding- Theory, comparison on merits, limitations and applications. Fluxes used in arc welding.

Unit II **(8)**

GAS welding: - processes and equipment used, type of flames, adjustment of flames, oxyacetylene welding, gas cutting –merits, limitations and applications.

Electric resistance welding- processes and equipment used, spot, seam, projection, butt, percussion welding, resistance tube welding, - merits, limitations and applications.

Unit III **(8)**

Pressure welding, diffusion welding, ultrasonic, friction, explosive, forge, thermit welding, laser, electron beam welding- equipment used- merits, limitations and applications of above processes.

Brazing, braze welding and soldering processes.

Inspection and testing of welding: - visual inspection, destructive & non-destructive testing. Estimation of welding cost. Protection and safety in welding.

Unit IV (8)

Sand casting processes , Principles of casting, steps involved in casting, Introduction of sand casting. Patterns, Pattern materials, pattern allowances and design. Core prints and core seats. Mould strength, Ingredients of moulding materials and their effect on mould strength-testing of mould strength, testing of moulding sand.

Melting and pouring of metals:- melting furnace- types, Cupola, electric arc furnace, Induction furnace- Construction, operations and zones, cleaning, finishing of casting.

Unit V (8)

Special casting processes Pressure and gravity die casting (hot and cold chamber), shell moulding, centrifugal casting, continuous casting, investment casting, - their typical applications, merits and limitations.

Casting defects- defects, Inspection- analysis of casting defects- Quality control. Foundry mechanization and automation.

Unit VI (8)

Casting Design, Metal pouring, Gating system- design of gating system, solidification time, riser design, Principles of gating, risering and their design methods. Progressive and directional solidification, casting design consideration, Chvornov's rule, numerical on casting, defects in casting. Fluidity- method of measuring fluidity of metal by spiral technique.
Computer applications in casting design and software.

Text Books

1. Rao P.N., "Manufacturing Technology, Foundry, Forming and welding", 2ed., Tata McGraw-hill publishing, 2006, ISBN 0-07-463180-2.
2. Khanna O.P., "Welding Technology", Dhanpat Rai& sons, 1996.
3. Khanna O.P., "Foundry Technology", Dhanpat Rai& sons, 1999.
4. Parmar R.S., "Welding Process and Technology", 2ed.,Khanna Publishers, 1997.

Reference Books

1. KalpakjianSerope and Schmid Steven, "Manufacturing Engineering & Technology", 2004.
2. Degarmo E.P. and Black J.T., "Materials &Processes in Manufacturing", 9ed., Prentice hall of India Pvt.Ltd., 2002.
3. Little Richard., "Welding & Welding Technology",Tata Mc-graw hill Publishing, 1992, ISBN 0-07-099409-9.

Material Science

211104

Teaching Scheme
Lectures: 3 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 3

Prerequisites: Physics, Chemistry

Course Objectives:

- To present the fundamentals of materials science and engineering
- To develop understanding of behavior of materials, structure-property correlation, their testing and strengthening mechanisms
- To select suitable materials for particular application

Course Outcomes:

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

- Explain the mechanism of plastic deformation
- Define the mechanical properties of materials and conduct destructive and non destructive tests to evaluate and test the properties of materials
- Draw and explain equilibrium diagrams for various alloy systems
- Understand various strengthening mechanisms
- Describe various pyrometers with a neat sketch and explain their working and application
- Understand corrosion and suggest various means to prevent corrosion
- Explain various aspects of powder metallurgy

Unit I **(8)**

Introduction

Classification of Engineering Materials, Structures and their property relationship in relation to engineering materials, indexing of planes and directions. Plastic deformation - Mechanisms. Deformation of Single crystal and Polycrystalline materials. Numerical based on it. Imperfections in crystals. Dislocations, work hardening. Cold and Hot working of metals. Numericals based on plastic deformation, future trends in new materials & applications.

Unit II **(8)**

Material Testing: Destructive Testing

Engineering and True Stress - True strain curves, conversion Relationships, Evaluation of properties. Numericals based on Tension Test. Engineering stress - Strain curves of different materials. Compression Test, Cupping Test on Sheet metal, Hardness Tests – Brinell, Poldi, Vickers, Rockwell Shore scleroscope, Durometer, Moh's test, Microhardness test and hardness conversions. Impact tests, Fatigue and Creep tests. Shear and Bend Test, Torsion Test.

Non-destructive tests

Visual Inspection, Magna flux test Dye penetrant test, Sonic and Ultrasonic test, Radiography. Examples of selection of NDT & mechanical testing methods for selected components like

crankshafts,.gears, razor blades, welded joints, steel and cast iron castings, rolled products, forged products.

Unit III **(8)**

Equilibrium diagrams

Related terms and definitions Hume Rothery's rule of solid solubility.Gibb's phase rule. Polymorphism, Solidification, Dendritic growth. Cooling curves, plotting of equilibrium diagrams, Lever rule, Isomorphous system. Coring.Eutectic systems, Partial eutectic systems.Uses of eutectic alloys. Layer type system, other transformation, non-equilibrium cooling and its effects

Unit IV **(8)**

Strengthening Mechanisms

Refinement of grain size, Solid solution hardening, Dispersion hardening, Age hardening, Martensitic transformation, Composite materials etc.

Pyrometry

Principle, Operation and uses of various pyrometers like thermocouples Resistance pyrometer, Disappearing filament pyrometer, Total radiation pyrometer.

Unit V **(8)**

Methods of Surface Improvements and Corrosion Prevention

Corrosion Prevention Methods: Design and material selection, atmosphere control, electroplating, Inhibitors, Cathodic and anodic protection, Coatings etc. Introduction to surface modification techniques such as Electro deposition, Diffusion coatings, Vapour deposition Thermal Spray Coatings, Ion implantation etc

Unit VI **(8)**

Powder Metallurgy

Process in brief, powder characteristics, powder manufacturing, Production of sintered structural components such as self lubricated bearing, cemented carbide tools, cermets, refractory metals, electrical contact materials, friction materials, Diamond impregnated tools etc.

Text Books

1. Kodgire V. D., “Material Science and Metallurgy for Engineers”, Everest Publishing House, Pune, 2008, ISBN 81-86314-00-8.
2. Smith W.F., “Principles of Material Science and Engineering”, McGraw Hill Book Co., 2002.ISBN: 0070591695
3. Shigley J. E., “Applied Mechanics of Materials”, McGraw Hill Book Company, 1985.ISBN:0070568456

Reference Books

1. Davis H. E., Troxell G.E. and Wiskocil C. T., “Testing of Engineering Materials”, McGraw Hill Book Co.ISBN:0070662479
2. Van Vlack L.H., “Elements of Material Science”, Addison- Wesley Publishing Co., 1998.ISBN: 8131706001
3. Baldev Raj, Jayakumar T. and M. Thavsimuthu, “Practical Non-Destructive Testing”, Narosa Publishing House.Delhi, 1999.ISBN: 8173197970
4. Hull and T. W. Clyne, “An introduction to Composite Materials”, Second Edition Cambridge Solid State Science Series.ISBN:0521735483

5. Structure and Properties of Materials II, Willey Eastern (P) Ltd.
6. Murthy, “Structure and properties engineering materials”, Tata McGraw Hill 2003.ISBN: 007048287X
7. Donald R. Askland, Phule P. P., “Science and engineering of materials”, Thomson Learning, 2003.ISBN: 0534553966

Heat and Fluid Engineering Lab

211105

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Term Work: 25 marks
Credit: 1

Practical and Term Work
Any eight, (Any one trail should be computer interfaced)

1. Verification of Bernoulli's equation
2. Determination of friction factor for laminar and turbulent flow through pipes
3. Determination of losses in various pipe fitting /Assignment on major and minor losses
4. Calibration of venture meter/orifice meter
5. Trial/Assignment on boilers.
6. Trial on vapor compression refrigeration system
7. Trial/Assignment on petrol engine
8. Trial on diesel engine
9. Trial on air compressor.
10. Trail / Assignment on Air conditioning system

Welding and Foundry Lab

211106

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Oral: 50 marks
Credit: 1

Students should prepare practical report on at least eight experiments on the topics mentioned below and workshop jobs. Oral will be based on the practical report.

1. To find out grain fineness number by using sand sieve shaker test.
2. Permeability testing of green sand.
3. Green compression test for molding sand.
4. Fluidity testing of any metal using fluidity spiral.
5. Study of TIG/MIG welding process parameters for ferrous and nonferrous metals.
6. Tensile test on a welded specimen.
7. Impact test on a welded specimen.
8. Non-destructive test on a weldment- dye penetrant test.
9. Non-destructive test on a weldment- magnaflux test.
10. Industrial visit to any foundry.

Workshop Jobs

1. Making simple solid pattern involving wood turning operation and preparing mould and aluminium casting.(one job)
2. Gas welding / Arc welding (one job)

Material Science Lab

211107

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Oral: 50 marks
Credits: 1

Students should prepare practical report on following experiments Oral will be based on the practical report.

1. Tensile test on mild steel and aluminium test pieces.
2. Compression test on cast iron and brass test pieces.
3. Brinell hardness test on different materials.
4. Poldi hardness test on different materials.
5. Vickers hardness test on different materials.
6. Rockwell and Rockwell superficial test on different materials with different Scales.
7. Izod and Charpy impact tests.
8. Erichsen cupping test on minimum three different sheet metal samples.
9. Non- destructive testing - magnaflux testing, dye penetrant test, ultrasonic testing, eddy-current testing

Machine Drawing & Computer Graphics Lab

211108

Teaching Scheme
Practical: 4 hours / week

Examination Scheme
Term Work: 50 marks
Oral: 50 marks
Credits: 2

Prerequisites: Engineering Graphics-I, Engineering Graphics-II,

Course Objectives:

- To develop the technical skills necessary to generate an engineering drawing and an engineering assembly using a modern CAD system
- To introduce the elements of engineering communications; including graphical representation of Machines end its elements.
- To model simple assembly drawings and prepare detailed part drawings with geometric dimensioning and tolerancing

Course Outcomes:

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

- Represent different kinds of materials and Mechanical components conventionally as per standards
- Identify and indicate appropriate surface roughness, tolerances and fits on drawing of machine components
- Identify the elements of a detailed drawing and produce the assembly drawing using part drawings
- Draw2D/3D models and assembly of machine elements using computer graphics
- Prepare parametric programming of standard machine parts using Autolisp.

Unit-I
Conventions in Machine Drawing

Introduction to machine drawing, Dimensioning technique for machine components, Conventional representation of machine components as per IS code: SP-46 such as screw threads, springs, gears, bearing, tapped holes, knurling, splined shafts, tapers, chamfers, countersunk and counter bores, keys, & welded joints,

Surface Roughness

Introduction, terminology**,** machining symbol with all parameters, roughness values (Ra) and roughness grade numbers, indicating surface roughness on drawing.

Unit-II
Tolerances& Fits

Definitions applied to tolerances, types of tolerance, types of fits, fit system. Geometrical tolerances – Nomenclature, tolerance frame, types of geometrical tolerances & their symbols, indicating geometric tolerances on drawing,

Standard Fasteners & Rivets.

Thread terminology, thread forms, thread designations, single and multi-start threads, right and

left hand threads, types of screws , bolts and nuts, nut locking arrangements using pins, washers & screws.

Rivets: forms & proportions of rivet heads, types of riveted joints.

Unit-III

Assembly & Details of Machine Parts

Introduction to assembly & part drawing ,examples-Revolving Centers, Machine Vice, Tool post, Screw Jack, jigs & fixtures, tailstock, Cotter Joint, Knuckle Joint, Flange Joint, Rigid and Flexible Coupling, Drawing reading. – Title block, part list / bill of material, revision block etc.

Unit IV

Basics of computer graphics

Software configurations, functions of graphics package, constructing the geometry, mathematical representation of various graphics elements such as line, circle, rectangle, ellipse, arc, spline etc.

2-D transformations

Geometric transformations, translations, rotation, mirror, concatenations.

Unit V

Fundaments of solid modeling

Geometry and topology use of primitives in solid modeling, Basics of Boolean operations, and representations schemes of solids, B-rep and CSG, Development of simple solids.

Unit VI

Autolisp programming:

Introduction to Autolisp, data types in Autolisp-integers, Real numbers, strings, Data type conversion, Math functions, logical functions, working with list and entities, filtering from lists, entity handling, list operators, string functions, branching and looping, introduction to visual lisp. Parametric programming.

Term Work:The term work shall consist of following:

Part I: Sketches of conventional representation of machine components as per **IS code: SP 46** such as: screw threads, tapped holes, holes on circular pitch, bearing, knurling, splined shaft, springs, gears, tapers, chamfer, countersunk and counter bore, keys, welded joints, structural sections etc., drawn neatly in the sketch book.

Part II: To compile the AutoCAD drawing prints etc., as mentioned below:

1. On half imperial drawing sheet - Conventional representation of machine components as per **IS Code: SP 46** such as: Screw threads, Tapped hole, Holes on circular pitch, Bearing,Knurling, Splined shaft, Springs, Gears, Tapers, Chamfer, Countersunk and counter bore.
2. On half imperial drawing sheet- Types of screws, Bolts and nuts, Nut locking arrangement.
3. On half imperial drawing sheet- Assembly and details of any one of machine component: Cotter joint, Knuckle joint, Flange joint, Rigid and flexible coupling, Stop valve, Non return valve, Revolving centers, Machine vice, Tool holder.
4. Mathematical representation of any two primitives.
5. 2D transformation of a simple two dimensional component.
6. Development of simple 3D model & Boolean algebra.

7. Any two programs on parametric programming involving :Programming for standardmachine components, Programming involving decision making and looping.

Text Books

1. Gill P. S., “A Text book of Machine Drawing”, Revised Edition K. Kataria and Sons, New Delhi, 2008, ISBN: 81-85749-79-5.
2. FarazdakHaideri, “Machine Drawing and Computer Graphics”, NiraliPrakashan, Pune, 1998.ISBN: 9380725272
3. William M. Oliver, “Illustrated Autolisp”, BPB Publications, New Delhi, 1997. ISBN: 1556221614
4. George Omura, “ABC’s of Autolisp”, BPB Publications, 2002.ISBN: 0895886200
5. Bhagat N. K., “Autolisp and Customisation Made Simple”, BPB Publication, 1997, ISBN: 817029712 5.
6. Zeid Ibrahim, “Mastering CAD/CAM”, Tata McGraw Hill.ISBN: 0070634343
7. Xiang Z. & Roy P., “Computer Graphics”, 2nd Edition, McGraw-Hill International Edition, 2001, ISBN 0-07-118885-1.
8. Groover M. P., “Automation Production Systems & Computer Integrated Manufacturing”, Prentice Hall of India, 1999, ISBN 81-203-0618-X.

Reference Books

1. Narayana K. L., Kannaiah P., VenkatataReaddy K., “Machine Drawing”, 2 nd Edition, New age international Publishers, Delhi, 2008, ISBN 81-224-1917-8.
2. Bhat N. D., Panchal , “Machine Drawing”, Charotar Pub. House, 2000.ISBN: 9380358466
3. Auto LISP Reference Manual”.
4. John Hood D., “Using AutoCAD with Auto LISP", McGraw Hill Book Company 1990.ISBN:0070297487

Audit Course 1: Road Safety

211109

Road transport remains the least safe mode of transport, with road accidents representing the main cause of death of people. The boom in the vehicle population without adequate road infrastructure, poor attention to driver training and unsatisfactory regulation has been responsible for increase in the number of accidents. India's vehicle population is negligible as compared to the World statistics; but the comparable proportion for accidents is substantially large.
The need for stricter enforcement of law to ensure greater safety on roads and an environment-friendly road transport operation is of paramount importance. Safety and security are growing concerns for businesses, governments and the traveling public around the world, as also in India. It is, therefore, essential to take new initiatives in raising awareness, skill and knowledge of students as one of the ibid stake holders who are expected to follow the rules and policies of the government in order to facilitate safety of individual and safe mobility of others.

Course Contents:

1. Existing Road Transport Scenario
2. Accident Causes & Remedies
3. Road Accident Investigation & Investigation Methods
4. Vehicle Technology – CMVR & Road Safety
5. Regulatory / Legislative Provisions for Improving Road Safety
6. Behavioral Training for Drivers for Improving Road Safety
7. Road Safety Education
8. Road Engineering Measures for Improving Road Safety

Electrical Technology

203050

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Basic Electrical Engineering

Course Objectives:

- To understand essential concepts and applications of electrical machines and drives.
- To understand concepts of semiconductor power devices

Course Outcomes:

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

- Understand and perform power measurement of single phase and three phases. Be able to understand the concept of Terrif and illumination
- Describe and classify the types of single phase transformer, tree phase transformer and three phase induction motor.
- Describe and classify the types of single phase induction motors and synchronous generators
- Understand construction and working of DC motors, generators and servo and stepper motors.
- Understand semiconductor devices and be able to predict their applications.
- Predict the advantages of various electric drives and speed control.

Unit I **(8)**

Electrical Power Measurement: Measurement of active power in three phase balanced loadsby using one wattmeter & two wattmeter, Concept of reactive power using two wattmeter, effect of power factor on wattmeter readings.

Electrical Energy Measurement: Single Phase and three phase energy meter, constructionand Working. Use of CT & PT for measurement of Power / Energy in single phase and three phase system (Theoretical Treatment only). Standard specifications of single and three phase energy meter, CT & PT for LT & HT measurements.

Tariff: Introduction, objectives & Details of H.T. and L.T tariff, TOD tariff, advantages andimprovement of power factor (Theoretical Treatment only)

Illumination: Various terms related to illumination, types and requirement good lightingscheme, special purpose lighting.

Unit II **(8)**

Single phase transformer: Types, KVA rating, approximate equivalent circuit, voltage regulation and efficiency of transformer, condition for maximum efficiency.

Three phase transformers: Types of transformer connection (star/star, star/delta, delta/star,and delta/delta) and applications based on connections. (Theoretical Treatment only) Introduction of power transformer, distribution transformer, study of typical distribution transformer substation, specifications of transformer (KVA rating, voltage ratio, current rating)

Three phase Induction Motor: Constructional feature, working principle of three phase induction motors, types; torque equation, torque slip characteristics; power stages; efficiency; types of starters; methods of speed control, Industrial applications.

Unit III **(8)**

Single phase induction motors: Types, construction, working principle of split phase and shaded pole type induction motors, applications. Specifications of induction motors (KW rating, rated voltage, current rating, frequency, speed, class of insulation)

Synchronous Generator: Constructional features, (Salient and non- salient),working principle,emf equation, synchronous speed of an alternator, concept of synchronous reactance and impedance, phasor diagram of loaded alternator, voltage regulation of alternator by direct loading method and synchronous impedance method. Specifications of synchronous generator

Unit IV **(8)**

D.C. Machines

Construction, working principle of D.C. generator, emf equation of D C generator.(Theoretical concept only).Working principle of D.C. motor. Types of D. C. motor, back emf , torque equation for D.C. motor, characteristics of D. C. motor (series, shunt and compound), starters of D.C. shunt and series motor, methods for speed control of D.C shunt and series motors, Industrial applications.

Special purpose motors: Construction, working principle, characteristic and applications ofstepper motors, A.C. and D.C servomotors, universal motors.

Unit V **(8)**

Semiconductor power devices:

SCR: Construction detail, V-I Characteristics, Methods to turn ON, switching action during ON &OFF, specification, Concept of commutation of SCR. Applications. **DIAC**: Construction, V-I Characteristics. **TRIAC**: Construction, V-I Characteristics, turning ON process. **MOSFET**: Construction, transfer Characteristics, output characteristics, Methods to turn ON & OFF, applications. **IGBT**:- Construction detail, transfer Characteristics, output characteristics, Methods to turn ON & OFF, applications.. **GTO**: Construction, working, advantages and disadvantages

Unit VI **(8)**

Drives: Advantages of Electrical Drives, Individual & Group drives, selection of drives depending on load characteristics.

Speed Control: Single phase full converter fed D.C. Drives, Three phase converter fed D.C. Drives, Chopper Drives, two quadrant & four quadrant chopper drives, stator voltage control of three phase induction motor, frequency control of three phase induction motor, V/F control of three phase induction motor.

Text Books

1. Harold G, “Electrical Machinery Transformers and Controls”, Prentice Hall Publication ISBN: 0132473208.
2. Theodore Wildi, “Electrical Machine Drives and Power Systems”, Pearson Education Asia, 2004, ISBN 81 7808 972 6.
3. Bhag S., Guru and Hussein R. Hiziroglu, “Electrical Machinery and Transformers”, Oxford University Press, 2007, ISBN 0-19-5685-77-6.
4. Dr.Bhimbra P. S., “Power Electronics”, Khanna Publication. ISBN: 817409279X.
5. Pratap H., “Art & Science of utilization of Electrical Energy”, 3rd Edition, Dhanpat Rai& Sons.
6. Theraja B. L., “Electrical Technology”, S. Chand Publication Co. Ltd. ISBN: 8121924405
7. Rao P. V., “Power Semiconductor Drives”, BS Publication, Hyderabad. ISBN: 8178001608

Reference Books

1. Bhattacharya S. K., “Electrical Machines”, Tata McGraw Hill LTD, New Delhi, 2003, ISBN 0-07-463310 4.
2. Hughes E. and Smith I., “Electrical and Electronics Technology”, Pearson Education Asia, New Delhi, 2008, ISBN 81 317 1468.
3. Syed A. Nasar, “Electrical Machine Drives and Power Systems”, Vol. I, Pearson Education Asia, ISBN 81 7808 9726.
4. Veinott C. G. and Martits J. E., “Fractional and sub fractional Horse power Electrical Motors”, McGraw Hill Inc.US; 3rd Edition, 1993, ISBN 978-0070673908.
5. Siemens, “Electrical Engineering Handbook”, Wiley Eastern LTD, 1986. ISBN: 0855012315.
6. Kothari D. P. and Nagrath I. J., “Electrical Machines”, 3rd edition, Tata McGraw Hill. ISBN: 0070699674

Theory of Machines

211110

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Engineering Mechanics, Basic Mechanical Engineering

Course Objectives:

- To provide a fair understanding of the performance of various mechanisms and principal machine elements as regards their Kinematics and dynamics & Forming a base for studies in machine tool applications
- To develop the ability to analyze and understand the dynamic (position, velocity, acceleration, force and torque) characteristics of mechanisms such as linkages and cams.
- To develop the ability to systematically design and optimize mechanisms to perform a specified task.

Course Outcomes:

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

- Understand the basic knowledge of mechanism, their inversions, applications and velocity and acceleration analysis.
- Understand the use of mechanical elements like drives, brakes, dynamometer in machine tools.
- Understand theories of wear and friction, their effects, measurement and methods to minimize their effects in various mechanisms and machine tools.
- Understand the static and dynamic force analysis of mechanisms.
- Analyze experimentally mass moment of inertia and radius of gyration

Unit I **(8)**

Basics : Kinematic Link ,Types of links, Difference between machines, mechanism and structure, Kinematics pair, Types of constrained motion, Classification of Kinematics pairs, Kinematics chain, Degrees of freedom of mechanisms, Kutzbach and Grubler criterion, Equivalent linkage concept, Inversion of mechanism Mechanisms: Straight line mechanisms-Exact straight line and approximate straight line type, Steering gear mechanisms -Davis and Ackerman type.

Unit II **(8)**

Kinematic Analysis of Mechanisms: (Velocity Analysis) Concept of position, displacement and velocity of a point and link of a given mechanism, Kinematic analysis of mechanisms by -- Relative velocity method, graphical method, analytical method, Instantaneous Center method, (Numerical treatment expected) Kinematic Analysis of Mechanisms: (Acceleration Analysis) Concept of acceleration of a point and link of a given mechanism, Kinematic analysis of mechanisms by -- Relative velocity method, graphical method, analytical method, Coriolis Component of Acceleration, Klein's construction (Numerical treatment expected)

Unit III **(8)**

Friction and Wear: Laws of friction, Types of friction, mechanism of friction, friction analysis, types of wear, mechanism of wear, wear equation, factors responsible wear and friction, methods of reducing wear, lubrication and its mode, lubrication technique, tribology in metal cutting and working.

Unit IV **(8)**

Belt Drives : Types of belt drives, Types, Materials used for Belt. Velocity Ratio, Slip, Creep of belt. Length of an open and cross belt drive, Maximum power transmitted, Tension ratio, maximum tension in a belt, Advantage and disadvantages of a V-Belt Drive, Ratio of Driving Tension for V-Belt.

Unit V **(8)**

Brakes: - Types of brakes, Force analysis of brakes, external and internal expanding shoe brakes, block brakes, band brakes, block and band brakes, Breaking torque. (Numerical treatment expected)

Dynamometer: - Different types of Absorption and transmission dynamometers.

UnitVI **(8)**

Static force analysis of slider-crank mechanism, Theory of compound pendulum, Bifilar and Trifler suspension methods, dynamically equivalent two mass systems, correction couple, Dynamic force analysis of slider crank mechanism (Analytical and Graphical method)

Text Books

1. Ballaney P. L., “Theory of Machines and Mechanisms”, Khanna Publisher Delhi, 1999. ISBN: 817409122X.
2. Rattan S.S**.,** “Theory of Machines”, 2ed.**,**Tata McGraw-hill publishing, 2005, ISBN 007-059120-2.
3. Ghosh Amitabh and Malik Ashok Kumar, “Theory of mechanisms and Machines”, 3ed, Affiliated East West press, 2000, ISBN 81-85938-93-8.

Reference Books

1. Shigley Joseph Edward and Vicker John Joseph**.** “Theory of Machines and Mechanisms” **,** 3ed., 1995, Oxford University Press. ISBN 0-19-515598-x.
2. Thomas Bevan, “Theory of machines”, CBS publishers and Distributors, 1984. ISBN: 8131729656

Machine Tool Operations

211111

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Basic mechanical Engineering

Course Objectives:

- To provide an overview of tools, of conventional machine tools such as lathe, drilling, milling, grinding, shaper, planner, slotter, broaching etc.
- To understand the different operations performed on conventional machine tools
- To calculate the machining time on different conventional machine tools

Course Outcomes:

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

- Understand specifications, constructional features, and principle of working of various manufacturing processes
- Identify and select appropriate cutting tools for various machining operations
- Select/Suggest what process is best used for producing some product
- Design simple process plans for parts and products

Unit I **(8)**

Lathes

Classification, Specification, lathe parts, bed, headstock, tailstock, lathe accessories and attachments, lathe operations, taper turning methods, thread mechanism, back geared, tumbler geared, all geared headstock, Capstan & turret lathe, comparison, Machining time calculations, Introduction to CNC lathe.

Unit II **(8)**

Drilling, Boring and Reaming

Classification, specification, sensitive, radial, gang, multi-spindle, spindle and drill head assembly, types of drills, twist drill nomenclature, reamer, types of reamer, taps, cutting parameters, tool holding devices. Classification of boring machines, specifications, types boring tools, various operations performed, Machining time calculations, Introduction to jig boring.

Unit III **(8)**

Milling Machines

Classification, specification, Column and knee type milling machine, milling operations, standard milling cutters, geometry of milling cutter, attachments, universal dividing head, methods of indexing, gear train calculations, machining time calculations, Introduction to CNC milling.

Unit IV **(8)**

Shaper, Planer, Slotter and Broaching Machines

Standard parts of shaper, planner, slotter and broaching machine, specification, Crank and slotted

link mechanism, hydraulic shaper mechanisms, auto feed mechanism, open and cross belt drive mechanism for planner, operations, Types of broaching machine, specification, broach geometry, machining time calculations.

Unit V **(8)**

Grinding Machine

Classification, Abrasives, bonds, grit, grade, structure of grinding wheels, wheel shape and sizes, standard marking system, dressing & truing, glazing, loading, mounting and balancing of grinding wheels, Selection of grinding wheels. Grinding operations, machining time calculations.

Unit VI **(8)**

Surface finishing processes and coating

Super finishing processes, honing, lapping, buffing, polishing, tumbling, electroplating, galvanizing, metal spraying, and burnishing. Hot dipping, Study of process parameters of above processes.

Text Books

1. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, “Elements of Workshop Technology” Vol II, Media Promoters, ISBN-10: 8185099154
2. Rao P. N., “Manufacturing Technology & Foundry, Forming & Welding”, Vol I, II, Tata McGraw Hill Publishing Co., 2004, ISBN: 0 07 451863 1.
3. Jain R.K., “Production Technology”, Khanna Publishers, 2008, ISBN 81-7409-099-1.
4. Sharma P.C., “A Text Book of Production Technology- Manufacturing Processes”, S. Chand & Co., 2008, ISBN: 81-219-111-4-1.
5. Chapman W .A. J., “Workshop Technology” Vol. I, II & III, Edward Arnold Publishers, 1998, ISBN: 0 7131 3287 6.
6. HMT, “Production Technology”, Tata McGraw Hill Publishing Co., 1980. ISBN: 0-07-096443-2.
7. Degarmo, Black and Kosherth, “Materials & Processes in manufacturing”, 8th Edition, Prentice Hall of India Ltd, Delhi, 2002. ISBN: 8126525223.
8. Raghuwanshi B. S., “A course in Workshop Technology”, Vol. I, II, Dhanpat Rai& Co. ISBN: 81-7409-099-1

Design of Machine Elements

211112

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 4

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

Course objectives:

- To apply engineering design principles and methods to the proper analysis of a variety of common mechanical system components.
- To design these mechanical system components confirming to appropriate codes and standards so as to perform safely their intended functions in harmony with other components of the system

Course Outcomes:

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

- Understand the basic principles and process of machine design
- Analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts such as shaft, power screws, mechanical springs, gears, and bearings.
- Demonstrate knowledge on basic machine elements used in design of machine elements to withstand the loads and deformations for a given practical application.

Unit I **(8)**

Design Process: Machine Design, Traditional design methods, Basic procedure of MachineDesign, Requisites of design engineer, Design of machine elements, Sources of design data, Use of standards in design, Selection of preferred sizes.
Design of Simple Machine Parts: Factor of safety, Service factor, Design of simple machine parts- Cotter joint, Knuckle joint and lever.

Unit II **(8)**

Shafts: Design considerations in Transmission shafts with spur gear and pulley, splined shafts,Shaft design on strength basis, Shaft design on torsional rigidity basis, A.S.M.E. code for shaft design.
Keys: Classification of keys, Design considerations in parallel and tapered sunk keys, Design of square, flat and Kennedy keys.
Couplings: Design considerations, Classification, Design of Rigid, Muff coupling, Flange coupling and Flexible bushed pin coupling.

Unit III **(8)**

Power Screws: Types of screw threads, multiple threaded screws, Torque analysis with square and trapezoidal threads, Self-locking screw, Collar friction torque, Stresses in power screws, design of screw and nut, design of Screw jack.

Unit IV **(8)**

Mechanical Springs: Types, Applications and materials of springs, Stress and deflection equations for helical springs, Types of ends, Design of helical compression and tension springs,

Springs in series and parallel, Helical torsion spring, surge in spring.

Unit V **(8)**

Spur Gears: Various design consideration, Beam Strength, tangential loading module calculations, width calculations, type of gear tooth failures, Estimation of dynamic load by velocity factors and Spott's equation.

Unit VI **(8)**

Rolling Contact Bearings: Type, static and dynamic loading capacity, stribeck's equation, concept of equivalent load, load life relationship, selection of bearing from manufacturers catalogue, design for variable load and speeds, bearing probability of survival other than 90%, lubrication and mounting of bearing.

Term Work:

1) Term work shall consist of ONE design project. Design project shall consist of two imperial size sheets –one involving assembly drawing with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design projects should be in the form of 'Design of Mechanical System' comprising of machine elements studied and topics covered in the syllabus. Design data book shall be used wherever necessary to achieve selection of standardized components.
2) Problem based assignment on each unit

Text Books

1. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", McGraw- Hill publication Co. Ltd., 1989, ISBN 0-07-049462-2.
2. Spotts M. F. and Shoup T. E., "Design of Machine Elements", 8ed., Pearson Education pvt. Ltd., 2008, ISBN 81 -7758- 4219.
3. Bhandari V.B., "Design of Machine Elements", Tata Mcgraw-hill publishing, 1984,ISBN 0-07-0611416 4. Kannaiah, "Machine Design", Scitech publications Pvt. Ltd., 2003, ISBN 81-88429-10-4.
5. PSG, "Design Data", M/S DPV Printers, 1984.

Reference Books

1. Orthewein and William C. Orthewein, "Machine Component Design".
2. Robert C. Juvinall, "Fundamentals of Machine Component Design", 1999.
3. "PSG Design data", M/S DPV printers, Coimbatore, 2000.
4. Black paulH.and Adams O. Eugene, "Machine Design", 3ed.,McGraw-hill Book Company, 1999, ISBN 0–07-085037-2.
6. Hall Allens, Holowenko Alfred R., Laughlin Herman G., "Theory & Problems of Machine Design", McGraw-hill Book Company, 2000, ISBN 48333-7.

Engineering Metallurgy

211113

Teaching Scheme
Lectures: 4 hours / week

Examination Scheme
In-Sem (Online) :50 Marks
End-Sem (paper): 50 Marks
Credits: 4

Prerequisites: Material Science

Course Objectives:

- To acquaint students with the basic concepts of Metallography
- To impart knowledge of various heat treatment processes. Processing
- To acquaint student types, characteristics, processing and applications of different ferrous and non-ferrous Metal and Alloys
- To develop futuristic insight into Metals

Course Outcomes:

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

- Work with Iron-Iron carbide equilibrium diagram and apply this knowledge for classification of steels from microstructure observations
- Select proper Heat Treatment, Surface Hardening technique & Isothermal Treatments for the steels considering properties and service requirements
- Distinguish different Alloy Steels and Cast Irons based on chemical compositions and microstructures
- Familiarize with different types of non-ferrous alloys and Composites with their need, scope and applications

Unit I: **(8)**

Steels: Introduction to Metallographic, micro and macro examination, metallurgical microscope,etching. Steels: iron-iron carbide equilibrium diagram, Critical temperatures, Allotropy, cooling curve and volume changes of pure iron. Microstructure, non-equilibrium cooling of steel, widmanstatten structure, structure property relationship. Classification and applications of steels, specifications of some commonly used steels like BIS, EN, AISI, SAE.

Unit II: **(8)**

Heat treatment of Steels: Introduction to heat treatment furnaces and Furnace atmospheres,Transformation products of austenite, Time-temperature- transformation diagrams, Critical cooling rate, Continuous cooling transformation diagrams. Heat treatment of steels Quenching media, Annealing" Normalizing" Hardening" Retention of austenite" Effects of retained austenite" Elimination of retained austenite, Tempering" Secondary hardening, Temperature embrittlement, Quench cracks, Hardenability testing" Defects due to heat treatment and remedial measure.

Unit III: **(8)**

Surface Hardening & Isothermal Treatments: Carburising, heat treatment after

carburising,Nitriding, Carbonitriding, Flame hardening and Induction hardening. Commercial heat treatment practice of gears of different sizes, tools, springs. Isothermal heat treatments such as austempering, patenting, iso-forming, martempering, ausforrning.

Unit IV: (8)

Alloy Steels: Effects of alloying elements, classification of alloying elements. Stainless Steels,Sensitization of stainless steel, weld decay of stainless steel. Tool steels and tool materials, Heat treatment of high-speed steel. Special purpose steels with applications.

Cast irons: Classification, Gray cast iron, White cast iron, Malleable cast iron" Ductile Iron,Chilled and alloy cast irons. Effects of various parameters on structures and properties of cast irons, Heat treatments of cast iron. Applications of cast irons for different components of machine tool, automobiles, pumps etc.

Unit V: (8)

Non-Ferrous Alloys: Copper alloys - Brasses, Bronzes-: Tin, Aluminium, Beryllium, SiliconCopper nickel alloys, Nickel - Silver, Aluminium and aluminium alloys. Solders, Bearing materials and their applications, Precipitation hardening alloys. High Temperature materials such as Nimonics, Super alloys, Ti-alloys etc.

Unit VI: (8)

Modern Engineering Materials: Composites- Types, Characterization, Production techniques& applications. Metal -Matrix composites, Particulate &Fibre composites. Biomaterials, Nano materials, Sports materials.

Text-books:

1. Kodgire V. D., "Material science and metallurgy for Engineers", Everest Publishing House, Pune, ISBN 81 86314 00 8.
2. K. G. Bundinski, M. K. Bundinski , “Engineering Materials” Prentice Hall of India Pvt. Ltd., New- Delhi.
3. Higgins "Engineering Metallurgy", Part I Applied Physical Metallurgy, English Language book Society / Edward Arnold.
4. Smith W. F., “Principles of Material Science and Engineering", McGraw- Hill Inc. Book Company ISBN 0 07 122920 5.

Reference Books:

1. Rollason E. C., "Metallurgy for Engineering", ELBS Publishing.
2. Clark D.S.andVamey W. R. "Physical Metallurgy for Engineers", East-West PressPvt. Ltd., New Delhi.
3. Avner, *"An* introduction to physical metallurgy", TMH publication.
4. Donald R. Askeland&PradeepPhule. ,” The science and engineering of materials”,Thomson Asia Pvt.LTD, ISBN 981 243 855 6.

Electrical Technology Lab

203051

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Term Work: 50 marks
Credit: 1

Term Work:

Term work shall consist of experiments as listed below. Any 6 experiments from 1 to 8 in the list should be performed, and expt. no. 9 and 10 are compulsory.

1. Speed control of a D. C. shunt motor by armature voltage and flux control methods.
2. Load test on a D. C. shunt motor.
3. Load test on a D. C. series motor.
4. Measurement of active power in a three phase balanced inductive load using two wattmeter methods.
5. Regulation of an alternator by synchronous impedance method.
6. Regulation of an alternator by direct loading method.
7. Load test on a three phase induction motor.
8. Study of a) D.C. motor starters, b) three phase induction motor starter.
9. Study of V-I characteristics of SCR & TRAIC.
10. Study of a distribution transformer substation and HT/LT energy bill.

Theory of Machines Lab

211114

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Term Work: 25marks
Oral: 50 marks
Credit: 1

Term work shall consist of the following:

1. Study of straight line mechanisms.
2. Velocity analysis of mechanism by relative velocity, Klein's construction and ICR method.
3. Acceleration analysis of mechanism by relative velocity and acceleration (Coriolis component), Klein's construction method.
4. Study of friction and wear of materials.
5. Study of belt drives.
6. Study of different types of brakes and dynamometer.
7. Determine mass MI of rigid body using bifilar and trifler suspension method.
8. Determine radius of gyration & mass MI of rigid body using compound pendulum method

Oral will be based on practical report on above mentioned topics.

Engineering Metallurgy Lab

211115

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Oral: 50 marks
Credit: 1

Students should prepare practical report on any eight of the following experiments. Oral will be based on the practical report.

1. Study and drawing of microstructures of mild steel, medium carbon steel, eutectoid steel and hypereutectoid steel.
2. Study and drawing of microstructures of white, malleable, grey and nodular cast iron.
3. Study and drawing of microstructures of alpha brass, alpha-beta brass, aluminium bronze, tin bronze and bearing metal.
4. Study and drawing of microstructures of hardened steel, tempered steel.
5. Hardening of steel- study of effect of carbon on hardness of hardened steel.
6. Tempering of steels - study of effect of temperature on hardness of tempered steel.
7. Study of change in microstructure on annealing and normalizing of tempered steel.
8. Sulphur print test on a steel specimen & flow lines examination of a forged component.
9. Jominy hardenability test on a steel sample.
10. Testing of composite materials (Like Hardness, Impact, Tension etc.)

Production Practice-I

211116

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Oral: 50 marks
Credit: 1

Course Objectives:

- To Study and practice various operations that can be performed using lathe, drilling,and milling machines. and
- To impart practical knowledge required in the core manufacturing industries.

Course Outcomes:

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

- Operate various machines like lathe, milling etc.
- Perform plain turning, taper turning etc. on lathe machine
- Perform gear cutting operation on milling machine.
- Understand the all gear drive, back gear mechanism of lathe.
- Perform the forging operation for knife edge and Vee shape tool.

Each candidate shall be required to complete and submit the following Term Work:

Part I: Assignments based on Machine Tools (any five)

1. Major operations on a lathe.
2. Working principle of apron mechanism in a lathe.
3. Thread cutting operation on a lathe using half-nut and lead screw.
4. Indexing mechanism and universal dividing head in milling machine.
5. Operations on drilling machine and the different work and tool holding devices used.
6. Single and multi-point cutting tools used on the conventional machines.
7. Calculation of machining time for different operations on lathe, milling and drilling machines.
8. To prepare the process sheet for the job(s) manufactured in turning (machine) shop during the practical session.

Part II: Jobs (any two)

1. Plain & taper turning (one job)
2. Gear cutting (one job)
3. Forging and grinding of a tool with one end consisting of knife edge and other end of Vee shape (one job).

Note: Oral examination will be based on the Term Work submitted by the candidate.

References

1. S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, “Elements of Workshop Technology” Vol II, Media Promoters, ISBN-10: 8185099154.
2. Gerling H., All about machine tools, New Age International, ISBN-108122418260.
3. JutzzH., “Westermann Tables for the Metal Trade”, New Age International, ISBN-10: 8122417302.

Soft Skills

211117

Teaching Scheme
Practical: 2 hours / week

Examination Scheme
Term Work: 25 marks
Credit: 1

Objectives

- To encourage all round development of students by training them in necessary soft skills.
- To make the engineering students realize the importance of soft skills in the holistic development of personality.
- To foster the students soft skills with a special emphasis on improving their communicative competence in English.

Overview

Soft skills are a set of skills required for a holistic development of an individual. Through this course, the students of engineering will be trained in the necessary soft skills which are required for them not only to do well academically but also to excel in each significant aspect of life. Effective communication skills in English have become a prerequisite for students to enhance their academic performance as well as earn a good placement. These skills are also essential for their professional growth. Therefore, the necessary soft skills will be taught with a special emphasis on communication skills in English. Today, the employability of a student is defined by not only his command over technical skills but also his sound soft skills. The soft skills improve students' confidence and enable them to implement the technical skills learnt more efficiently. Training in soft skills infuses in students positive attitude and makes them self assured. They can do well in every walk of life and achieve success in their endeavors. Thus, soft skills contribute significantly to the all round development of students and therefore need to be taught effectively with an emphasis on adequate practical exposure.

Teaching Methodology

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate onlyin English during the session. Specific details about the teaching methodology have been explained in every activity given below.

Practical Activities (Term work)

Following 10 activities are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should give students 10 assignments on the basis of the 10 activities conducted in the practical sessions. Students will submit these 10 assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. Self Assessment: (2 hours)

The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

2. Public Speaking (4 hours)

Any one of the following activities may be conducted :

a. **Prepared speech** (topics are given in advance, students get 10 minutes to preparethe speech and 5 minutes to deliver.
b. **Extempore speech (**students deliver speeches spontaneously for 5 minutes eachon a given topic)
c. **Story telling (Each student narrates a fictional or real life story for 5 minutes each)**
d. **Oral review** (Each student orally presents a review on a story or a book read bythem)

3. Power-point Presentations (4 hours)

Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.

4. Formal Group Discussion (4 hours)

Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback.

5. English Language Proficiency Test (2 hours)

The teacher should conduct a 50 mark English proficiency test in the lab and discuss the answers with explanation and more illustrations.

6. Mock Meetings (2 hours)

In order to enhance students' formal oral communication, mock meetings can be conducted. Teacher should give a topic for the meeting and teach students how a notice and agenda for a meeting is prepared. Students will participate in the meeting assuming the roles assigned by the teacher. After the meeting, teacher should guide students on how minutes of meeting are recorded.

7. Letter, Report & Resume writing (4 hours)

Each student will write one formal letter, one report and a resume. The teacher should teach the students how to write the letter, report and build resume. The teacher should give proper format and layouts.

8. Reading and Listening skills (4 hours)

The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

9. Conflict Management and decision making skills (2 hours)

The teacher should teach students how to make sound and practical decisions by dealing with conflicts. Students should know how to manage internal and external conflicts. The teacher can conduct a case study activity to train students in these skills.

10. Stress management (2 hours)

The teacher should conduct a session on stress management and guide students on how to manage stress. The teacher may conduct a stress relieving activity in the class. He/she may counsel students individually to know their problems and guide them on dealing with them effectively.

Scheme of Evaluation

The teacher should give marks out of 10 for each activity. The total marks for all 10 activities will be 100 marks. At the end of semester, the marks scored by a student out of 100 will be scaled down to marks out of 25. Thus, each student will get marks out of 25 for this subject.

References

1. Rutherford A. J. : Communication skills for Technical Communication, Pearson Education
2. Meenakshi Raman, Sangeeta Sharma : Technical Communication – Principles and practice, Oxford
3. Scot Ober : Contemporary Business Communication (Indian adaptation) Biztantra
4. Dutt et.al. : A course in Communication Skills, Foundation
5. Ibbotson: Cambridge English for Engineering, Cambridge
6. Turk: Effective Speaking, Taylor & Francis
7. Patnaik: Group Discussion and Interview Skills, Foundation
8. Mishra: A companion to communication skills in English, PHI
9. Lynch: listening, Cambridge
10. Sasikumar, Dutt&Rajeevan: A course in Listening & Speaking I & II, Foundation
11. Malcom Goodale: Professional Presentations, Cambridge
12. Ham-Lyons &Heasley: Writing, 2nd Edition, Cambridge
13. ASTD: 10 steps to successful meetings, Cengage Learning
14. E. Suresh Kumar, P. Sreehari, J. Savitri: Communication Skills & Soft Skills An Integrated Approach, Pearson
15. Barun K. Mishra: Personality Development and Group Discussions, Oxford University Press
16. Accenture, Convergys, Dell et.al: NASSCOM - Global Business Foundation Skills: A Foundation Books, Cambridge University Press

Audit Course 2: Environmental Studies
211118

Environmental studies are the field that examines this relationship between people and the environment. An environmental study is an interdisciplinary subject examining the interplay between the social, legal, management, and scientific aspects of environmental issues.

Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures.
- Understand and realize the multi-disciplinary nature of the environment, its components, and inter-relationship between man and environment
- Understand the relevance and importance of the natural resources in the sustenance of life on earth and living standard

Course Outcomes:

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

- Comprehend the importance of ecosystem and biodiversity
- To correlate the human population growth and its trend to the environmental degradation and develop the awareness about his/her role towards environmental protection and prevention
- Identify different types of environmental pollution and control measures
- To correlate the exploitation and utilization of conventional and non-conventional resources

Course Contents:

1. Natural Resources: Introduction, Renewable and non-renewable, Forest, water, mineral, food, energy and land resources, Individual and conservation of resources, Equitable use of resources.

2. Ecosystems: Concept, Structure, Function, Energy flow, Ecological succession, Forest, grassland, desert and aquatic ecosystems - Introduction, characteristic features, structure and function.
3. Biodiversity: Genetic, Species and ecological diversity, Biogeographical classification of India, Value and hot spots, Biodiversity at global, national and local levels, India as mega-biodiversity nation, Threats to biodiversity, Endangered and endemic species of India, Conservation of Biodiversity, Endangered and endemic species, Conservation of biodiversity.
4. Pollution: Definition, Causes, effects and control measures of the pollution – Air, soil, Noise, Water, Marine and Thermal and Nuclear Pollution, Solid waste management, Role of Individual in Prevention of Pollution, Pollution case studies, Disaster management

References:

1. Bharucha, E., “Textbook of Environmental Studies”, Universities Press (2005), ISBN-10:8173715408
2. Chapman, J.L. and Reiss, M.J., “Ecology- Principles and Application”, Cambridge University Press (LPE) (1999), ISBN-9780521588027
3. Joseph, B., “Environmental Studies”, Tata McGraw-Hill (2006), ISBN-0070590923
4. Miller, G.T., “Environmental Science- Working with Earth”, Thomson (2006), ISBN-13:978-0-

495-55671-8
5. Wright, R.T., “Environmental Science-Towards a sustainable Future”, Prentice Hall (2008), ISBN-13:978-0130936547, 9th Edition