# Production Engineering

## UNIVERSITY OF PUNE

### COURSE STRUCTURE FOR

### BE (Production Engineering) (2012 Course)

#### SEMESTER-1

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>Teaching Scheme (Hrs/week)</th>
<th>Examination Scheme</th>
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Lect: Lectures  Tut: Tutorial  PR: Practical  TW: Term Work  OR: Oral

### Elective I

(a) Human Factors in Engineering and Ergonomics  
(b) Financial Management and Costing  
(c) Reliability Engineering  
(d) Energy Management

### Elective II

(a) Advanced Welding  
(b) Materials Technology  
(c) Surface Engineering  
(d) Intelligent Manufacturing Systems
# B. E. [Production Engineering] Syllabi 2012 Course

## SEMESTER –II

<table>
<thead>
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Lect: Lectures    Tut: Tutorial    PR: Practical    TW: Term Work    OR: Oral

### Elective III

(a) Materials and Logistic Management

(b) Finite element analysis

(c) World Class Manufacturing

(d) Industrial Relations and Human Resources

### Elective IV

(a) Industrial Robotics

(b) Simulation and Modeling

(c) Automobile Engineering

(d) Mechatronics
411081
MACHINE TOOL DESIGN

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Drives
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
Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables.

Unit III: Design of Guide ways
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.

Unit IV: Design of Spindles, Spindle Supports and Power Screws
Design of spindle and spindle support using deflection and rigidity analysis, analysis of antifriction bearings, preloading of antifriction bearing. Design of power screws: Distribution of load and rigidity analysis.

Unit V: Dynamics of machine tools
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 VI: Special Features of Machine Tools
Design considerations of Stepless drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking.

Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices.
References:

411082
AUTOMATION AND CONTROL ENGINEERING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Basics of Automation [6]
Definition, concepts, types of automation, low/medium/high cost, hard/flexible automation, semi/fully automation in machine tools, job/material transfer devices Introduction to automated material handling and storage - ASRS, AGV.

Unit II: Hydraulic fluid power automation [6]
Advantages of hydraulic fluid power automation, operational principles and uses of hydraulic power system, functioning of hydraulic components such as pumps, filters, control devices, linear and rotary actuators, hydraulic control for industrial application, design and development of hydraulic circuits for simple application areas involving selection of hydraulic components for specific applications, electro hydraulic principles and components used in electro-hydraulic, industrial applications based on electro hydraulic, proportional valves and activation technology, industrial applications with proportional valves.

Unit III: Pneumatic Systems [6]
Operational principles and application, air compressors, Pneumatic cylinders and air motors, Pneumatic valves, functions of different pneumatic components and selection, construction of pneumatic controls and circuit diagrams for conveying, feeding, clamping, indexing, cutting and non-cutting operations.

Unit IV: Programmable Automation [6]
Introduction to microprocessor, Microcontroller, Microcontroller based manufacturing systems, Logic gate and control, Computer process controls - any manufacturing case study.

Unit V: Control System [6]
Data conversion (ADC/DAC), Programmable logic controller, Interfacing circuits, Actuating signals, relays, contactors, Types of control systems - P, PI, PID, Optimal control system.

Unit VI: Automated Assembly, And Shop Floor Control [6]

Oral shall be based on the above term work and practical.
Text Books:

Reference Books:
7. Vickers manual on hydraulics
411083
OPERATIONS RESEARCH

Teaching Scheme  Examination Scheme
Lectures: 4 hrs/week  In semester: 30 Marks

Unit I: Linear programming (LP)  [10]

Unit II: Transportation and Assignment problem  [8]

Unit III: Introduction to Integer, Dynamic and Non-linear programming  [6]
Integer programming, Branch &Bound 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: Network modeling  [8]

Unit V: Replacement models and Games Theory  [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.

Games Theory: Introduction, Two -person zero sum game, Minimax and maximin principle, Saddle point, Methods for solving game problems with mixed strategies, Graphical methods, Solution using LP.
**Unit VI: Queuing theory and Simulation**

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**


**Reference Books**

411084

**ELECTIVE-I (A): HUMAN FACTORS IN ENGINEERING AND ERGONOMICS**

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
In semester: 30 Marks
End semester: 70 Marks

**Unit I: Introduction to Human Factors** [8]

Human criteria’s, human physical activities, features of the human body, Measures of physiological functions such as: energy expenditure, gross body activity, local muscular activity, work load, work efficiency, work and rest. Type of movements of body members. Performance criteria for physical activity such as: Strength & endurance speed of movements, accuracy of movements, manual material handling (MMH).

**Unit II: Applied Anthropometry and Work Space** [8]

Introduction to anthropometry, use & principles of anthropometry data, work spaces, work space envelopes for seated persons, design of work spaces such as: work surface height, seated & standing, principles of seat design, workplace design. Physical space & arrangement, principles of arrangement of component,

**Unit III: Design of Displays and Controls** [8]

Information input & processing, visual displays of static & dynamic information. Auditory, textual & olfactory displays general location of controls & displays within workspace, concept of visibility. Functions of controls, types of controls, factors in control design, design of specific hand operated controls, foot controls and special control devices.

**Unit IV: Working Conditions** [8]


**Unit V: Energy Expenditure** [8]

Muscle mechanism, BMR, Heart Rate variations, Oxygen consumption, Rest allowances, Rate of energy expenditure, Manual Material Handling Capacity determination, Effect of environmental conditions and work design on Energy Expenditure.
Unit VI: Ergonomics and Work Organization

Human factors and ergonomics standards, Human factors applications in system design, characteristics of system design, human factors data for interface design, ergonomic safety and health management, case studies of ergonomically designed product.

Text Books


Reference Books:

ELECTIVE-I (B): FINANCIAL MANAGEMENT & COSTING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Financial Management

Unit II: Capital Budgeting
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
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


Unit V: Budgetary control and variance Analysis:

Unit VI: Types of Costing Methods
Text Books:


Reference Books:

ELECTIVE-I (C): RELIABILITY ENGINEERING AND TERROTECHNOLOGY

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Fundamentals of Reliability Engineering
Reliability definition, reliability concept, quality, failure, patterns of failure, causes of failure, common distributions in failure mechanisms–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:

Unit III: Maintainability and Availability
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
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
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

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:


Reference Books

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Energy Scenario
Global primary energy reserves and consumption pattern, Indian energy scenario, sector wise energy consumption, energy needs of growing economy, energy pricing in India, energy security importance of energy conservation and introduction of energy conservation act 2001.

Unit II: Energy Economics and Energy Audit
Energy economics: Simple payback period, time value of money, return on investment, net present value and internal rate of return. Energy Audit: Methodology, analysis and reporting, portable and online instruments required for energy audit, sankey diagram and specific energy consumption.

Unit III: Thermal Systems
Boiler efficiency calculations by direct and indirect method, various losses, steam distribution nd 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 Systems
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, Lighting: illumination level, fixtures, timers, energy efficient illumination.

Unit IV: Energy Conservation
Energy conservation in: Compressed air systems, refrigeration and air conditioning systems, pumps, fans, D. G. set and cooling tower.

Unit VI: Cogeneration and Waste Heat Recovery
Cogeneration: Concept, technical options, classification of cogeneration system i.e. topping and bottoming cycle, selection criteria, applications. 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.
7. W. C. Turner, editor: The efficient use of energy (Butterworths)
411085
ELECTIVE-II (A): ADVANCED WELDING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit 1: Introduction
[7]

Unit 2: Advanced Welding Techniques
[7]
Principle and working and application of advanced welding techniques such as Plasma Arc welding, Laser beam welding, Electron beam welding, Ultrasonic welding etc.

Unit 3: Weld Design
[7]

Unit 4: Metal Transfer And Melting Rate
[7]
Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate.

Unit 5: Thermal And Metallurgical Consideration
[7]

Unit 6: Welding Of Plastics And Composites
[7]
Principle of welding plastics, common weldable plastics, welding joint design, surface preparation, plastic welding processes, principle of operation, equipment required, Advantages, Applications.

References:

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

**Unit I: Elastic and Plastic Behavior** [7]

Elasticity in metals and polymers, Mechanism of plastic deformation, role of dislocations, Yield stress, shear strength of perfect and real crystals, Strengthening mechanisms, work hardening, solid solution and grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviours, Super plasticity, Deformation of non crystalline material.

**Unit II: Fracture Behavior** [7]

Griffith's theory, stress intensity factor and fracture toughness, Toughening mechanisms, Ductile-brittle transition in steel, High temperature fracture, creep: Larson-Miller parameter, Deformation and fracture mechanism maps, Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law, Effect of surface and metallurgical parameters on fatigue, Fracture of non metallic materials, Failure analysis, sources of failure, procedure of failure analysis.

**Unit III: Selection of Materials** [7]

Motivation for selection, cost basis and service requirements, Selection for mechanical properties, strength, toughness, fatigue and creep. Selection for surface durability corrosion and wear resistance, Relationship between materials selection and processing, Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

**Unit IV: Modern Metallic Materials** [7]

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides, Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials, biomaterials.

**Unit V: Non-Metallic Materials** [7]

Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, Al2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.
Unit VI: Composite Materials

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.

References:

411085
ELECTIVE-II (C): SURFACE ENGINEERING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Introduction of Surface Dependent Properties
[7]
Introduction to various corrosion prevention methods, Classification and scope of surface modification techniques in metals, ceramics, polymers and composites, Tailoring of surfaces of advanced materials, Surface dependent engineering properties, viz. wear, friction, corrosion, fatigue, reflectivity, emissivity, etc., common surface initiated engineering failures, mechanism of surface degradation; importance and necessity of surface engineering.

Unit II: Various Surface Cleaning Processes
[7]
Classification and Selection of Cleaning processes, Acid and Alkaline Salt bath, Ultrasonic, Mechanical cleaning, Pickling and de-scaling, study of process details, applications and Environmental concern of each cleaning method, Electrochemistry and electro-deposition, electro less deposition Process details. Scope and application of conventionally deposited materials like Copper Nickel.

Unit III: Coatings
[7]
Various coating types like Cathodic and Anodic coatings, Hot dipping (Tinning, Galvanising, Aluminising), Metal cladding, Diffusion coatings like carburising, nitriding, cyaniding, Sherardising, Calorising and Chromosing. Chemical conversion coatings like Phosphate, Chromate, Oxide, and Anodized. Various Organic coatings like Paints, varnishes, Enamel and Lacquers Thermal spray coatings, like Flame spray, Electric arc spray, Plasma spray, High velocity Oxy Fuel (HVOF) coating.

Unit IV: Other Surface Engineering Processes
[7]
Influence of manufacturing processes on various surface properties of an engineering component, scope of surface engineering in augmentation of surface properties, Physical vapour deposition (PVD), Chemical vapour deposition (CVD) Process, Plasma enhanced Surface engineering, Ion Implantation, thin films coatings for engineering surfaces.

Unit V: Testing and Characterization Of Coatings
[7]
Control properties, response properties, surface geometry characterization Techniques (conventional and recent trends), coating thickness measurements, laboratory techniques and
special techniques for accurate routine thickness measurements, adhesion measurement, conventional methods and recent developments, Quality assurance of coating process.

Unit VI: Recent Trends in Surface Engineering

Measurement of mechanical properties of engineered surface in nano scale, Evaluation of tribological characteristics of engineered surface in macro, micro and nano scale, simulation of actual application environment in tribometer, High temperature coatings, Wear resistant coatings Use of Laser in Surface Engineering, Environmental protection issues.

References

411085
ELECTIVE-II (D): INTELLIGENT MANUFACTURING SYSTEMS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Introduction to artificial intelligent techniques

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

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

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

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

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)

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:

411086
MACHINE TOOL DESIGN

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
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 stepless drives
4. Design for spindle or power screw.
5. Design for guide ways and slide ways.
6. Internet assignment based on any one of the topics above.
411087
AUTOMATION AND CONTROL ENGINEERING

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Practical: 50 Marks

Practical Work:

1. Study of basics of automation.
2. Study of hydraulic circuits - hydraulic press, machine tools, automobile systems, etc
3. Study of pneumatic circuits.
4. Use of microprocessors: Applications in manufacturing engineering.
5. Study and experiments in programmable logic controllers: Ladder logic programming
6. Study of data conversion (ADC/DAC)
7. Study of automation in material handling system.
8. * Industrial visit report on automation in any Industry.
   * Industrial visit is compulsory.
### 411088
OPERATIONS RESEARCH

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<td>Practical: 2 hrs/week</td>
<td>Term work: 50 Marks</td>
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**Term Work:**

One exercise on each unit. At least one Computer Software Package such as Lindo/Lingo, MATLAB, MS-Excel/MS-Projects, Tora etc. should be used.
411089
ELECTIVE II (A): ADVANCED WELDING

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term work will be based on one assignment on each Unit.
ELECTIVE II (B): MATERIALS TECHNOLOGY

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term work will be based on one assignment on each Unit.
411089
ELECTIVE II (C): SURFACE ENGINEERING

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<td>Term work: 50 Marks</td>
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Term work will be based on one assignment on each Unit.
411089
ELECTIVE II (D): INTELLIGENT MANUFACTURING SYSTEM

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term work will be based on following assignments:

2. Study of Artificial Intelligent techniques with application examples
3. Case studies on industrial decision making using fuzzy multiple attribute decision making
4. Applications of artificial neural networks to manufacturing engineering
5. Study of various clustering algorithms for group technology
6. Study of algorithms for robot path planning/obstacle avoidance
7. Case study on route optimization of AS/RS systems.
B. E. [Production Engineering] Syllabi 2012 Course

411090

PROJECT PHASE-I

Teaching Scheme
Tutorial: 2 hrs/week

Examination Scheme
Term work: 50 Marks

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. Above work shall be taken up individually or in groups. The group shall not be more than 4 students.

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
   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 Seminar Report shall be submitted to the college. The students shall present their Project Phase-I report.
COMPUTER INTEGRATED DESIGN & MANUFACTURING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Computer Aided Design (CAD) [6]

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.

Geometric modeling: Wireframe modeling, Surface modeling: Representation of curves and surfaces, design of curves: cubic splines, bezier curves and B-spline, design of surfaces. Solid modeling techniques.

Unit II: Computer Applications in Engineering Analysis [6]

One dimensional problems: Finite elements modeling, 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, Problem modeling and Boundary conditions, Axi-symmetric Solids subjected to axi-symmetric loading,

Unit III: Computer Aided Manufacturing (CAM) [6]

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 ,


Unit IV: Computer Integrated Manufacturing (CIM) [6]

Computer application in manufacturing automation and Robotics, Robot programming, computer aided inspection and quality control. Computer integrated production management system, inventory, material requirement planning, manufacturing resource planning, enterprise resource planning

Unit V: Group Technology Cellular Manufacturing and Flexible Manufacturing System [6]


Unit VI: CIM Models and Rapid Prototyping


Term Work:

The term work shall consist of assignments based on the following topics. Evaluation of practical will be based on Oral examination.
2. Programming on CNC Lathe/Milling.
3. Programming on Robot application.
6. Simulation of a simple mechanical system

Text Books:


Reference Books:

411092

PRODUCT DESIGN & DEVELOPMENT

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In-semester: 30 Marks
End semester: 70 Marks

Unit I
Introduction to Product Design
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, Concept generation and selection, Concept testing, Prototyping, and product cost analysis, Embodiment design, Detail design, Planning for manufacture, Planning for distribution, Planning for use, Planning for retirement of the product, Product cannibalization and petrification.

Unit II
Approaches and techniques for Product Design
Mass customization, Kano model, Kansei engineering, Conjoint analysis, Product architecture, Modular product architecture, Product line design, Product configuration and concurrent engineering, Product data management.

Unit III
Product Development Process:
Product life cycle, Generic product design process, Stage gate system of product development, Types of products, Product planning, Markets and marketing, Markets, Market segmentation, Functions of a marketing department, Elements of a marketing plan, Technological innovation, Invention and Diffusion, Business strategies related to innovation and product development.

Unit IV
Understanding customer requirements
Identifying customer needs, Voice of customers, Methods of Voice of customers (VoCs) preliminary research on customers’ needs, Gathering information from customers, Customer requirements, Differing views of customer requirements, Classifying customer requirements, Establishing the engineering characteristics, Benchmarking in general, Competitive performance benchmarking, Reverse engineering or product dissection, Determining engineering characteristics, Types of design information, Sources of design information, Quality function deployment, The house of quality, Steps for building a house of quality.

Unit V
Design for X
Role of manufacturing in design, Types of manufacturing processes, Types of manufacturing systems, Manufacturing process selection quantity of parts required, Shape and feature
complexity, Influence of material on process selection, Required quality of the part, Cost to manufacture, Availability, Lead time, and delivery, Further information for process selection.


**Unit VI**
Innovative Case Studies in Product Development
Case studies confined to auto industry, Home appliances, etc., Software based applications and case studies in PLM.

**Text Books**

1. A.C. Chitale and R.C. Gupta, Product Design and Manufacturing by PHI.

**Reference Books**

### ELECTIVE-III (A): MATERIALS AND LOGISTIC MANAGEMENT

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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</thead>
<tbody>
<tr>
<td>Lectures: 3 hrs/week</td>
<td>In semester: 30 Marks</td>
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<tr>
<td></td>
<td>End semester: 70 Marks</td>
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</tbody>
</table>

#### Unit I: Materials Management [8]

Introduction to Material Management functions, scope, objectives, tools and techniques. Make or buy decision, Material Requirement Planning (MRP1).

**Value analysis:** Value analysis / Value analysis engineering, concepts, advantages, applications, problem recognition, role of creativity, analysis of functions, use, esteem and exchange values elimination of unnecessary costs, value engineering techniques.

#### Unit II: Purchase Management [8]

Objectives, functions, purchase cycle, documents in purchasing, purchasing with 5 R’S (Quality, Quantity, Time, Supplier, Price), vendor rating and vendor development.

**Import and Import Substitution:** Factors affecting National and International markets, Import procedure and documents (Bill of lading, letter of credit etc.)

#### Unit III: Stores Management [8]

Functions of stores, types of stores, stores identification, receipt-issue, recording system, stock taking system.

**Waste Management:** Importance of waste management and techniques. waste management system, Disposal of surplus and obsolete items. Mechanical and thermal disposal system.

#### Unit IV: Logistic Management [8]

Operating Responsibility, Logistical performance Cycle, Work of Logistics, Functional areas of logistics

**Warehouse Management:** Nature and importance of warehousing, warehouse location, warehousing operations and Facility development. Economic and service benefits of warehouse.

**Transportation Management:** Transport planning parameters, Basic Economics & pricing factors affecting transportation cost.

#### Unit V: Supply Chain Management [8]

Introduction, Types of supply chain, Components, Drivers, Role of supply chain in manufacturing, Supply chain performance and its measurement, Planning, Demand and supply in supply chain, Risk in supply chain and managing the risk, Coordination in supply chain.
Unit VI: Inventory control of finished goods

Economic manufacturing quantity (EMQ), Fixed order quantity and fixed order interval system, Probabilistic models, Safety stocks, service levels, inventory control of finished goods, single order inventory policies. Inventory models under risk and under uncertainty.

Text Books:


Reference Books:

ELECTIVE-III (B): FINITE ELEMENT ANALYSIS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Introduction
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
Introduction, Plane trusses, Assembly of global Stiffness Matrix for Banded Skyline solutions.

Unit III: Two-Dimensional Problem Using Constant Strain Triangles
Introduction, finite element formulation, load considerations and boundary conditions, problem modeling, member end forces, plane frame.

Unit IV: Axi-symmetric solids subjected to axi-symmetric loading
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
Introduction, steady state heat transfer - 1D and 2D heat conduction and convection, governing differential equation, boundary conditions, formulation of element.

Unit VI: Software based FEA
Mesh generation, meshing techniques, meshing in critical areas, type and size of element, mapped elements, quality checks-[aspect ratio, warp angle, skew, Jacobean, distortion, stretch, included angle, taper], boundary conditions, interpretation of results and design modification.
### Teaching Scheme

Lectures: 3 hrs/week

### Examination Scheme

In semester: 30 Marks  
End semester: 70 Marks

#### Unit I: Historical Perspective


#### Unit II: Benchmark, Bottlenecks and Best Practices


#### Unit III: System and Tools for World Class Manufacturing


#### Unit IV: Human Resource Management in WCM


#### Unit V: Typical Characteristics of WCM Companies

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

#### Unit VI: Indian Scenario

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

### Text Books

References:

ELECTIVE-III (D): INDUSTRIAL RELATIONS AND HUMAN RESOURCES

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Introduction to Management

Characteristics, objectives Functions, Principles and Types of Management., Scientific Management—Contribution of F. W. Taylor, Henry Fayol and Indian contributors


Unit II: Motivation: Human


Group dynamics: Characteristics of group, The meaning of group & group behavior & group dynamics, Types of groups

Leadership: Definition, styles & functions of leadership, qualities for good leadership, role of the leader, Theories of leadership, Managerial grid.

Unit III: Human Resource Management:


Unit IV: Training and Development of Manpower:

Need of Training, Benefits of Training, Method of Training Workers, training curriculum planning; choice of training methodologies; training facilities and equipments; in-service training; outside training; re-training; advanced training; designing training programmes; employee counseling; executive development programmes; evaluation of training and development programmes Foreman or Supervisory Training, Executive-Managers Training and Development, Learning curves and classifications, Management By Objectives [MBO]

Unit V: Industrial Relations:

Definition of Industrial Relations, History, Governmental Measures – Ministry for labor, Commissioner of labor, Deputy Commissioner & Labor Offices. The various approaches to Industrial Relations, Impact of Liberalization, Privatization and Globalization on Indian
Industrial Relations, successful industrial relations programme, industrial discipline, grievances, Industrial Health and Industrial Safety, Trade Unions, Principles of public relations, Collective Bargaining, Worker participation in Management, concept of Quality of Work Life (QWL)

**Wages and Incentives:** Concept of wages, factors affecting wages, Types of wage plans, Job Analysis, Job Evaluation and Merit Rating, Payment of wages act-1936 The Employees’ Provident Fund & Miscellaneous Provisions Act, 1952

**Unit VI: Industrial Acts/Laws:**


**Text Books**


**Reference Books**

ELECTIVE-IV (A): INDUSTRIAL ROBOTICS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit 1: Basic Concepts in Robotics [8]
Automation and robotics, robot anatomy, 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, P, PI & PID control systems.

Unit II: Robot Arm Kinematics and Dynamics [8]
The direct kinematics problem, the inverse kinematic solution, Homogeneous transformation.

Unit III: Robot Grippers [8]
Classification, Design consideration, Materials for hostile operation. Cylindrical Cam type; Grippers using pneumatic, hydraulic and electrical motor for transmission; Vacuum Grippers, ultrasonic grippers.

Unit IV: Sensors and Machine vision systems in Robotics [8]
Vision system: Median filtering, thresholding, discretisation, Smoothening of binary image. Edge detection algorithm, region growing algorithm.

Unit V: Robot Programming and Artificial Intelligence [8]
Robot Programming: Methods of Programming the robot, Methods of defining positions in space, Motion interpolation, branching. Textual robot programming languages.
Artificial Intelligence: Concept of A.I., Approaches, foundations of A.I. Problem formulation: Problem solving agents, components of problem definition, defining the problem as state space approach.

Unit VI: Advanced Applications of Robots and Robot Interfacing [8]
Obstacle Avoidance: Lee's Algorithm; Counter Path Defining using 'via' point, blending technique.

**Text Books:**


**Reference Books**

B. E. [Production Engineering] Syllabi 2012 Course

411094
ELECTIVE-IV (B): SIMULATION & MODELING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Principles of Simulation and Modeling [8]
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 [8]
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 [8]
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 [8]
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 [8]
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

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:

2. Education Private Ltd, New Delhi, 2010.

References:

411094

ELECTIVE-IV (C): AUTOMOBILE ENGINEERING

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

In semester: 30 Marks
End semester: 70 Marks

Unit-I: Introduction to Automobile Engineering & safety

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.

Classification and construction of I.C. engine

Unit II: Fuel supply system and cooling systems.


C.I. engine – classification of fuel supply system- solid injection system fuel injection pump

Bosch Pump and injector

Cooling system – necessity of cooling, under cooling, overcooling, types of cooling system components, working of pressurized force & thermostatic, coolant additives

Unit III: lubrication and Ignition system

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.

Ignition System – battery, magneto and electronic ignition system, comparison, different starting system used in automobiles

Unit IV: Drive train and vehicle performance

Types of clutches, single plate, multiplate centrifugal clutches, clutch operating systems, Wet clutches, fluid coupling, clutch plate material Functions of gear box, 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, selection of gear ratio sliding mesh, constant mesh and epicyclic gear boxes, Synchromesh devices, automatic gear boxes, torque converters, overdrive
Unit V: Suspension and steering system

Suspension Systems- Objects of suspension, principles of suspension design spring and unsprung mass, types of springs, torsion bars, rubber springs, shock absorbers, independent suspension air suspension, interconnected suspension, hydro pneumatic suspension, self leveling suspension

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

Unit VI: Braking system and Automobile maintenance

Braking systems - used in automobiles Braking systems used in automobiles layout and working antiskid braking (ABS)

Automobile maintenance - Preventive maintenance Troubleshooting and diagnosis for Clutch & Gear Box Troubleshooting and diagnosis for Brake and Steering Troubleshooting and diagnosis for Suspension

Text Books


Reference Books

2. Domkundwar & Domkundwar : Internal combustion Engine, Dhanpat rai
ELECTIVE-IV (D): MECHATRONICS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
In semester: 30 Marks
End semester: 70 Marks

Unit I: Introduction to Programmable Controllers
Definition, A Historical Background, Principles of Operation, PLCs Versus Other Types of Controls PLC Product Application, Ladder Diagrams and the PLC Advantages of PLCs

Logic Concepts
The Binary Concept, Logic Functions, Principles of Boolean Algebra and Logic, PLC Circuits and Logic Contact Symbology

Processors, the Power Supply, and Programming Devices
Introduction, Processors, Processor Scan, Error Checking and Diagnostics, The System Power Supply, Programming Devices

Unit II: The Discrete Input/Output System (8)
Introduction to Discrete I/O Systems, I/O Rack Enclosures and Table Mapping, Remote I/O Systems, PLC Instructions for Discrete Inputs, Types of Discrete Inputs, PLC Instructions for Discrete Outputs, Discrete Outputs, Discrete Bypass/Control Stations, Interpreting I/O, Specifications, Summary of Discrete I/O

Unit III: The Analog Input/Output System (8)
Overview of Analog Input Signals, Instructions for Analog Input Modules, 7-3 Analog Input Data Representation, Analog Input Data Handling, Analog Input Connections Overview of Analog Output Signals, Instructions for Analog Output Modules, Analog Output Data Representation, Analog Output Data Handling, Analog Output Connections Analog Output Bypass/Control Stations

Unit IV: Special Function I/O and Serial Communication Interfacing (8)
Introduction to Special I/O, Special Discrete Interfaces, Special Analog, Temperature, and PID Interfaces, Positioning Interfaces, ASCII, Computer, and Network Interfaces, Fuzzy Logic Interfaces, Peripheral Interfacing

Unit V: Programming Languages (8)
Introduction to Programming Languages, Types of PLC Languages, Ladder Diagram Format, Ladder Relay Instructions, Ladder Relay Programming, Timers and Counters, Timer Instructions, Counter Instructions, Program/Flow Control Instructions, Arithmetic Instructions, Data Manipulation Instructions, Data Transfer Instructions.

Unit VI: Data Measurements and Transducers (8)
Text Books:


Reference Books:

411095

COMPUTER INTEGRATED DESIGN & MANUFACTURING

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Practical: 50 Marks

**Practical work**

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

2. Programming on CNC Lathe/Milling.
3. Programming on Robot application.
6. Simulation of a simple mechanical system
### 411096

**PRODUCT DESIGN & DEVELOPMENT**

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tbody>
<tr>
<td>Practical: 2 hrs/week</td>
<td>Oral: 50 Marks</td>
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</table>

Oral 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
411097

ELECTIVE III (A): MATERIALS AND LOGISTIC MANAGEMENT

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Term work: 50 Marks

Term work will be based on one assignment on each unit.
Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term Work:

The term work shall consist of record of any three from 1 to 4 (C/MATLAB programs) and any three from 5 to 8 assignments of the problems based on following topics:

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.
7. Stress and deflection analysis of any machine component consisting of 3-D elements using FEA software.
B. E. [Production Engineering] Syllabi 2012 Course

411097
ELECTIVE III (C): WORLD CLASS MANUFACTURING

<table>
<thead>
<tr>
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<th>Examination Scheme</th>
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</thead>
<tbody>
<tr>
<td>Practical: 2 hrs/week</td>
<td>Term work: 50 Marks</td>
</tr>
</tbody>
</table>

Term work will be based on one assignment on each unit.
B. E. [Production Engineering] Syllabi 2012 Course

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ELECTIVE III (D): INDUSTRIAL RELATIONS AND HUMAN RESOURCES

<table>
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<tr>
<td>Practical: 2 hrs/week</td>
<td>Term work: 50 Marks</td>
</tr>
</tbody>
</table>

Term work will be based on one assignment on each unit.
411098

ELECTIVE IV (A): INDUSTRIAL ROBOTICS

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term Work

The term work shall be based on the following assignments

1. Study of configuration of robots and motion of robot manipulator
2. Study of direct kinematics and inverse kinematic solutions (Numerical Problems)
3. Study of robot grippers (includes the problems based on gripper force)
4. Study of machine vision system
5. Study of robot drives and control
6. Study of robot interfacing with PC
7. Study on advanced industrial applications of robots
8. Programming the robot for pick and place operation
411098
ELECTIVE IV (B): SIMULATION AND MODELING

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term work will be based on one assignment on each unit.
411098

ELECTIVE IV (C): AUTOMOBILE ENGINEERING

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term Work

The term work shall be based on any Six of the following assignments

1. Study of fuel injection systems for SI and CI engines.
2. Study of cooling systems in an automobile.
4. Study of different types of clutches.
5. Study of transmission system in an automobile.
6. Study of wheel alignment.
7. Study of different types braking system.
8. Study of independent suspension system.
9. Study of preventive maintenance, trouble shooting for clutch, steering, brake, suspension and gear box systems in an automobile.
411098
ELECTIVE IV (D): MECHATRONICS

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 Marks

Term work will be based on six assignments on the above syllabus and any six of following practical:

1. Study of switches and relays
2. Development of ladder diagram and simulation
3. PLC circuit and Logic contact symbology
4. Study of load cell trainer
5. Study of data acquisition system
6. Calibration of flow meter
7. Calibration of thermocouple
8. Verification of PID control system
9. Study of lever measurement trainer
10. Displacement measurement using LVDT

The practical may involve the use of automation and simulation software for preparation of ladder diagram and PLC circuit.
Teaching Scheme
Tutorial: 06 hrs/week

Examination Scheme
Term work: 50 Marks
Oral: 100 marks

PROJECT WORK

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. Above work shall be taken up individually or in groups. The group shall not be more than 4 students.

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
   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 Seminar Report shall be submitted to the college. The students shall present their Project Phase-I report before the examiners. The oral examination shall be based on the term work submitted and jointly conducted by an internal and an 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:
   1. Title page
   2. Certificate form Institute
   4. Acknowledgement
   5. Abstract
   6. Index
   7. Nomenclature and Symbols
   8. Actual Content
   9. Conclusion
   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.
7. Blank sheets: No blank sheets be left anywhere in the report.
8. 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)