Savitribai Phule Pune University

Faculty of Science & Technology

Curriculum for

Third Year

Production Engineering

(2019 Course)

(with effect from June 2021)

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

Semester-V

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Seminar	IN-Sem	End-Sem	TW	PR	OR	Total	TH	PR	Seminar	Total
311081(A)	Engineering Metrology and Instrumentation	3			30	70				100	3			3
311082(A)	Material Forming Technology	3			30	70				100	3			3
311083(A)	Machining Science and Technology	3			30	70				100	3			3
311084(A)	Kinematics and Design of Machines	3			30	70				100	3			3
311085(A)	Elective-1	3			30	70				100	3			3
311081(B)	Engineering Metrology and Instrumentation-Lab		2					50		50		1		1
311082(B)	Material forming technology –Lab		2						25	25		1		1
311083(B)	Machining Science and Technology-Lab		2				25			25		1		1
311084(B)	Kinematics and Design of Machines- Lab		2						25	25		1		1
311085(B)	Elective-1 Lab		2				25			25		1		1
311086	Seminar			1			50			50			1	1
311087	Mandatory Audit Course 5	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**1**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**5**	**1**	**21**

Elective 1:

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

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

I. Disaster Management
II. Industrial Waste Management

Savitribai Phule Pune University, Pune TE (Production Engineering) 2019 Course (With effect from Academic Year 2021-22)														
Semester-VI														
Course Code	**Course Name**	**Teaching Scheme (Hours/Week)**			**Examination Scheme and Marks**						**Credit**			
		Theory	**Practical**	**Internship**	**IN-Sem**	**End-Sem**	**TW**	**PR**	**OR**	**Total**	**TH**	**PR**	**Internship**	**Total**
311088(A)	Production Tooling	3			30	70				100	3			3
311089(A)	Production and Operations Management	3			30	70				100	3			3
311090(A)	Process Engineering and Resource Planning	3			30	70				100	3			3
311091(A)	Elective 2	3			30	70				100	3			3
311088(B)	Production Tooling-Lab		2						50	50		1		1
311089(b)	Production and Operations Management--Lab		2				25			25		1		1
311090(B)	Process Engineering and Resource Planning--Lab		2				50			50		1		1
311091(B)	Elective 2 Lab		2					50		50		1		1
311092	Fabrication Lab		2				25			25		1		1
311093	Internship			4			100			100			4	4
311094	Mandatory Audit Course 6	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**12**	**10**	**4**	**120**	**280**	**200**	**50**	**50**	**700**	**12**	**5**	**4**	**21**

Abbreviations:

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

Elective 2:

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

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

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

Engineering Metrology and Instrumentation

311081(A)

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

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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, MillingMachine, etc.
- Basic knowledge of standard machine components such as: Gear, spring, Screw threads etc.

Course Outcomes:

After learning this subject, the student will able to:

1. Describe and work with linear and angular measuring devices
2. Design limit gauges and work with special measuring devices for gear, screw thread and surface finish measurements
3. Distinguish various comparators and use profile projector
4. Use various control charts and various quality assurance tools
5. Implement quality standards for industrial application.
6. Implement TQM and TPM concepts in practice.

Unit I : Concept of measurement , Limits, fits and tolerances (6)

Linear Measurement: Classification of Standards, Precision and Non Precision Measuring instruments, Slip Gauges.
Angular Measurement: Sine bar, Sine Center, Uses of sine bars, angle gauges, Auto Collimator, Angle Dekkor.
Comparators: Uses, Types, Advantages and Disadvantages of various Comparators.
Cost-Tolerance relationship, concept of Interchangeability, selective assembly, Indian Standard System. Design of limits Gaugesusing Taylor's Principle, Interferometry: Introduction, Flatness testing by interferometry, NPL Interferometer.

Unit II: Measurement of Thread, Gear and Surface finish (6)

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.
Surface Finish Measurement: methods of evaluation of surface roughness, Tomlinson's Surface Recorder, Talysurfand Taylor- Hobson SurfaceMeter
Recent Trends in Engineering Metrology, Universal coordinate measuring machine (CMM)

Unit III: Introduction to Quality and quality standards (6)

Meaning of Quality, Quality of Product, Quality of Service, Cost of Quality, Value of Quality, 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 Introduction to ISO 9001-2000, ISO 9000-1998 Series standards, ISO 14000

Unit IV: Quality Assurance tools and techniques (6)

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

Unit V: Introduction to measuring Instruments (6)

Classification of measuring instrument, Stages in generalized measuring system – Sensor-Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers. Performance characteristic of measuring devices –Static and dynamic

Unit VI : Measurement of stress, vibration and temperature (6)

Measuring instruments for - Strain and Stress Measurement, Force and torque, Vibration measurement, Temperature Measurement

Text Books:

1. K.J.Hume, "Engineering Metrology", Kalyani publication
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

Reference Books:

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 Organization,
4. Juran's Quality Handbook
5. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E , Pearson Prentice Hall, 2007
6. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004

Material Forming Technology

311082(A)

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

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Prerequisites: Manufacturing process I

Course Outcomes;
Students will be able to:

1. Describe mechanism of plastic deformation.
2. Classify and analyze various forming as well as special forming processes
3. Identify problems (defects) in forming processes and apply knowledge to overcome these problems.

Unit I: Fundamentals of Material Forming **(6)**

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: Forging **(6)**

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: Wire, Rod and Tube Drawing **(6)**

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 tubedrawing.

Unit IV: Rolling of Metals **(6)**

Scope and importance of rolling. Types of Rolling Mills - Construction and 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 : Extrusion **(6)**

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: Advances in Metal Forming **(6)**

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”

Machining Science and Technology

311083(A)

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

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Prerequisites: Manufacturing processes-I, Material science, Machine Drawing & Computer Graphics,

Course Outcomes:

Students will be able to:

1. Know with the basic concepts of machining science like mechanics of machining,
2. Evaluate Tool wear, tool life and cutting forces
3. Infer the different cutting tool geometry and economics of machining
4. Design and draw the different cutting tools Calculate the cutting force components in orthogonal cutting
5. Apply aspects of economics of machining in practice

Unit I : Mechanics of Machining **(6)**

Mechanics of chip formation, Types of chips Orthogonal & oblique cutting, Concept of feed, depth of cut and cutting speed, Geometry of single point tool, Tool signature, Mechanics of metal cutting- effect of tool-geometry and other cutting parameters, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's assumptions, Merchant circle and derivation of relationships between the cutting forces, chip thickness ratio, shear angle, stress and strain in the chip, work done and power required in metal cutting. Numericals based on metal-cutting

Unit II*:* Cutting tool Materials, standards &Dynamometry **(6)**

Cutting tool materials, Desirable properties of tool material, Coated tools , Coating techniques on tool, Heat treatment of tools Tool angle specification systems-British system, American system, German system, ISO system,
Nonconventional tool geometry: Koleshov tool, Antichatter tool, Gustin tool,
Classification of dynamometers, Study of working principles in Lathe, Milling, Drilling, Grinding dynamometers, piezoelectric dynamometry

Unit III *:* Thermal aspect, Tool life & Economics of cutting tools **(6)**

Sources of heat generation, Temperature in primary and secondary deformation zone, ,Effect of cutting speed on temperature, Tool wear and its type, Tool wear mechanism, Types of cutting fluids, Functions of cutting fluids, Characteristics of cutting fluid Selection of cutting fluids, Taylor's Tool life equation. Factors affecting tool life, Tool failure criteria.Machinability, Machinability rating, Machinability criteria, Economics of machining, Criteria for minimum cost & maximum production. Numerical based on tool life.

Unit IV : Tool life and machining economics: **(6)**

Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life. Taylors tool life equation. Experimental methods to find Taylor exponents. Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate.

Unit V: Design of single point cutting tools **(6)**

Design of shanks for single point solid cutting tools , tipped tools, , Chip breakers Throwaway indexable inserts , ANSI inserts specification, ANSI tool holder specification for indexable insert. Design of single point solid cutting tool.

Unit VI: Design of Multi point cutting tools **(5)**

Deign of drills, reamers, broaches, milling cutters, form tools, grinding wheels. Constructional details and fields of application of multipoint cutting tools.

Text Books:

1. Wilson, “Fundamentals of tool design”, A.S.T.M.E.
2. Dr.B.J.Runganath’”Metal Cutting and Tool Design”,Vikaspublication,ISBN0706975103
3. G. Kuppuswamy, “Principles of Metal Cutting”,University press, ISBN 8173710287.
4. Basu, Mukherjee and Mishra, “Fundamentals of Tool Engineering andDesign”, Oxford publishing.ISBN812040016X

Reference Books:

1. P C Sharma, “Production Engineering”. , Khanna publishers.ISBN8121904218.
2. P.C. Sharma, “Machine tools & Tool Design”. Khanna publishers,ISBN:812192362X.
3. Surender Kumar, “Production Engineering Design”,SatyaPublication
4. Dolalson, Lecain and Goold, “Tool design”, TataMcGrawhill.ISBN0070992746.
5. Hoffman, “Introduction to Jigs and fixtures”.Delnar Cengage LearningPublication
6. “Tool Engineering Handbook”, A.S.T.M.E.
7. R. K. Jain, “Production Technology”, KhannaPublishers.ISBN8174090991
8. Milton Shaw, “Metal cutting principle” CBSPublication

Kinematics and Design of Machines

311084(A)

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

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

Course 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, flywheel etc.
3. Design mechanical system for fluctuating loads.
4. Demonstrate optimum design principles and statistical considerations and apply it to mechanical components.

Unit I: Synthesis and Analysis of mechanisms (6)

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 and four bar mechanism, Over lay method, Bloch Synthesis

Unit II: Theory of spur gear and Gear Train (6)

Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, interference and under cutting – Methods to avoid interference.

Gear Trains: Simple, compound, epicyclic gear trains,Computation of velocity ratios and torque transmitted in epicyclic gear trains.

Unit III: Cams and Flywheels (6)

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, cycloidal

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 punching presses.

Unit IV: Design for Fluctuating Load (6)

Stress concentration-causes & remedies, fluctuating stresses, fatigue failures, S-N curve, endurance limit ,notch sensitivity, endurance strength modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg, Gerber, Goodman, Modified Goodman diagrams, Fatigue design of components under combined stresses.

Unit V: Statistical considerations in design (6)

Frequency distribution- Histogram and frequency polygon, normal distribution - units of of central tendency and dispersion-standard deviation - population combinations - design for natural tolerances - design for assembly - statistical analysis of tolerances, mechanical reliability and factor of safety.

Unit VI: Optimum Design and DFMA **(6)**

Optimum Design:

Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations, optimum design with normal specifications of simple machine elements- tension bar, transmission shaft and helical spring, Pressure vessel.

Design for manufacturing and assembly:

General principles of design for manufacture and assembly (DFM and DMFA), principles of design of castings and forgings, design for machining, design for safety.

Text Book

1. S.S.Ratan , ―Theory of Machines, Tata McGraw Hill [ISBN0070591202]
2. Ghosh Amitabh and Malik Ashok Kumar, "Theory of mechanisms and Machines", 3ed,Affiliated East West press, 2000, ISBN 81-85938-93-8.
3. P.L.Ballaney, ―Theory of Machine, Khanna Publisher.
4. Bhandari V.B. ―Design of Machine Elements, Tata McGraw Hill Pub. Co. Ltd.
5. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

Reference Books

1. J. E. Shigley and J.J.Uicker Jr., ―Theory of Machines and Mechanism‖, McGraw Hill
2. Thomas Bevan, "Theory of machines", CBS publishers and Distributors, 1984. ISBN:8131729656
3. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design, McGraw Hill Pub. Co.
4. M. F. Spotts, ―Mechanical Design Analysis‖, Prentice Hall Inc.

Elective 1- Finite Element Analysis

311085(A)-I

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

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

Course Outcomes

After successful completion of course student will able to,

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

Unit I: Introduction **(6)**

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

Unit II: Trusses **(6)**

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

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

Introduction, finite element formulation, load considerations and boundary conditions, problem modeling, member end forces, plane frame.

Formulation of elemental stiffness matrix and load vector for Plane stress/strain such as Linear Strain Rectangle (LSR), Constant Strain Triangles (CST), Pascal‘s triangle , primary and secondary variables, properties of shape functions.

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

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

Two dimensional iso-parametric elements

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

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

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

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

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

Text Books

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

Reference Books

1. Chandrupatla T. R. and Belegunda A. D., ―Introduction to Finite Elements in Engineering‖, Prentice Hall 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. Fundamental of Finite Element Analysis, David V. Hutton, Tata McGraw-Hill
8. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., ―Practical Finite Element Analysis‖, Finite to Infinite, Pune

Elective 1- Advances in Manufacturing Processes

311085(A)-II

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

Prerequisites: Manufacturing process I

Course Outcomes:

Students will be able to:

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

Unit I: Unconventional Machining Processes-I (6)

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

Unit II: Unconventional Machining Processes-II (6)

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

Unit III: Advanced Casting Processes (6)

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

Unit IV: Advanced Welding Processes (6)

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

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

Unit V: Advanced Fine Finishing Process (6)

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

Unit VI: Special manufacturing processes (6)

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

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

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

Text Books:

1. HMT, —Production Technology
2. Chapman; —Workshop Technology, Edward Arnold Publishers, ISBN 0 7131 3287 6
3. P. N. Rao, —Manufacturing Technology, Tata McGraw Hill, ISBN 0 07 451863 1.

4. Richard L. Little, Welding and Welding Technology, by-, McGraw Hill Education, ISBN:
5. R. S. Parmar, Welding Engineering and Technology, Khanna Publishsers, ISBN:

Reference Books:

1. P C Sharma; —Production Technology (Manufacturing Processes), S Chand & Co., ISBN 81 219 114.
2. Kalpakjian S, —Manufacturing Engineering and Technology, Pearson Education.
3. PablaAdithan, —CNC Machines, New age International Pub, ISBN 81 7808 157 1
4. Kundra B S, P N Rao, M Tiwari; —Numerical Control and Computer Aided Manufacturing —TATA McGraw Hill Pub. ISBN 0 07 4517 40 6.
5. Mikell P. Groover; —Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India Ltd, Delhi, ISBN 81 203 0618 X
6. Pandey, Shan; —Modern Machining Processes.
7. Ghosh Amitabh, A. Malik; —Manufacturing Science, East-West Press Pvt. LTD, ISBN 8185095 85 X.
8. P.N. Rao, —CAD/CAM/CIM Principles, Tata McGraw Hill Publication,
9. V.K. Jain, “Advanced Machining Processes” Allied Publishers Pvt. Ltd.
10. P.C Pandey & H.S. Shan, “Modern Machining Processes” McGraw Hill Education.
11. E. P. DeGarmo, J. T Black, R. A. Kohser, "Materials and Processes in Manufacturing" (8th Edition) Prentice Hall of India, New Delhi.
12. G.F. Benedict, Marcel Dekker, "Nontraditional Manufacturing Processes" Inc. New York.
13. Mishra P K “Non-Conventional Machining”, Narosa Publishers.
14. Singh K K “Unconventional Manufacturing Processes” Dhanpat Rai & Company, New Delhi.
15. H. Abdel and G. El-Hofy, Advanced Machining Processes: Nontraditional and Hybrid Machining Processes,1st edition, McGraw-Hill Professional, 2005. ISBN: 978- 0071453349

Elective 1-Mechatronics

311085(A)-III

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

Prerequisites: Electrical and Electronics Engineering

Course Outcomes:

After learning this subject, the student will:

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

UNIT I: Sensors and Transducers (6)

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

UNITII: Analog Signal Conditioning (6)

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

UNIT III: Interfacing (6)

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

UNIT IV: Modelling and Analysis (6)

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

UNIT V: Control System (6)

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

UNIT VI: PLC Programming (6)

Introduction to PLC Programming, Types of PLC Languages, Ladder Diagram Format, Ladder Relay Instructions, Ladder

Relay Programming, Timer Instructions with example Counter Instructions with example

Text Books

1. C D Johson, Process Control Instrumentation Technology, 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 Books

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

Elective 1-Supply Chain Management

311085(A)-IV

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 Outcomes

After Successful completion of this course students will able to,

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

UNIT I: Introduction **(6)**

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 **(6)**

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 **(6)**

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 **(6)**

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 **(6)**

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 **(6)**

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, 2013.
3. Daniel Stanton, Supply Chain Management For Dummies, John Wiley & Sons, 2017,
4. Martin Christopher, Logistics & Supply Chain Management, Pearson UK, 2016.

Reference books:

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.

Engineering Metrology and Instrumentation Lab

311081(B)

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

List of Experiments (Any Eight)

1. Linear and angular Measurement using precision/non-precision instruments.
2. Study of Comparators and Design of Limit Gauges.
3. Measurement of the Surface roughness
4. Measurement of Screw thread parameters using Floating Carriage Micrometer.
5. Measurement of Gear tooth thickness using Gear tooth Vernier caliper
6. Study of quality standards via Industrial visit
8. Study of Quality Assurance tools and techniques
9. Experiment on Mechanical Measurement systems
10. Experiment on Measurement of Stress, Vibration and Temperature

Material Forming Technology Lab

311082(B)

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

Oral will be based on term-work below

Term work:

Term work shall consist of:

1. Assignment based on each topic of syllabus
2. Study of roll pass design for one structural shapes -Round or Square
3. Report of Industrial visit (Min. 2 Industrial visit)

Machining Science and Technology- Lab

311083(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hours / week	Practical: 01	Term-work: 25 Marks

List of Experiments:

1. Experiments on chip formation.
2. Measurement of cutting forces (anyone) in Turning / Milling /Drilling.
3. Study of effect of tool geometry, cutting speed, feed, depth of cut on cutting parameters.
4. Design and working drawing of single point cutting tools
5. Design and working drawing of drills and reamers
6. Design and working drawing of broach
7. Design and working drawing of milling cutter

Kinematics and Design of Machines Lab

311084(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Lectures: 2 hours / week	Practical: 01	Oral:25 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. Determination of holding torque in epicyclic gear train.
3. To draw a cam profile for specific follower motion
4. Study of Flywheel in punching machines.
5. Assignment on Design machine component for fluctuating load
6. Assignment on Design machine component for statistical considerations.
7. Assignment on Design machine component for optimum design

Elective 1-Finite Element Analysis Lab

311085(B)-I

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

Elective 1-Advances in Manufacturing Processes-Lab

311085(B)-II

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

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

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

Elective 1-Mechatronics Lab

311085(B)-III

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

Lab Work (any 6)

1. Study of various types of sensors and transducers
2. Measurement of Displacement using LVDT
3. Measurement of Force using Strain Gauges
4. Stepper motor interface
5. Speed control of DC motor
6. PLC based hydraulic and pneumatic circuit design
7. Demonstration of Op-Amps for Summing and Inverting Amplifier
8. PLC program for any real time example e.g. elevator, conveyor, bottle filling plant

Elective 1-Supply Chain Management Lab

311085(B)-IV

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

Seminar

311086

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

1. The objective of Seminar is to test the student on his/her ability for self-study and his/her ability to communicate - Written and oral.
2. Seminar will be in the form of a report submitted by the student:
   a) On topic of his/her choice based on literature survey/ a case study wherever applicable/possible, and approved by the staff- in- charge.
   b) A report with 20-25 pages of A-4 size paper, 1.5 spaced typed material, and appropriately bound.
   c) Title font/figures/graphs shall be black and white.
3. The term work evaluation will be based on the report submitted and (orally) presented.

Mandatory Audit Course 5:
Disaster Management
311087

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

Course Contents:

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

Mandatory Audit Course 5:
Industrial Waste management
311087

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

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

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

References:

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

Production Tooling

311088(A)

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

Prerequisites: Machine drawing, Material, Manufacturing technology

Course Outcomes:

Students will be able to-

1. Design and draw jigs and fixtures
2. Choose appropriate dies/press tools/molds based on type of operations
3. Design and draw Press tools.
4. Design and draw forging dies
5. Design and draw injection molds.

Unit I: Design of Jigs and Fixtures **(6)**

Principles of location, 3-2-1 principle, 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, General guidelines and procedures for design of Jigs and fixtures, Economics of Jigs and fixtures, Modular fixture, Computer aided fixture design

Unit II: Design of Blanking dies and progressive dies **(6)**

Strip layouts, percent utilization, analysis of cutting force and stripping force, Method of reducing the cutting forces, calculation of press tonnage, clearance, Standards and specifications. Aspects of die design and drawing

Unit III: Design of Drawing and Bending Dies **(6)**

Design of shallow and deep drawing dies, Calculation of blank size by area and graphical method percentage reduction and diameter and height of cup in each stage in each stage, number of draws, drawing force and blank holding force in each draw, press capacity. Types of Bending dies, Developed length calculation, bending force, spring back

Unit IV: Design of Forging Dies **(6)**

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

Upsetting die: Rules for upset forging, design of upsetdie.

Unit V: Die casting die design **(6)**

Die casting process, machines, die casting materials, 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 VI: Design of Injection mold **(6)**

Plastic molding materials, types of plastic processing techniques, 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. Rao P.N., “Manufacturing Technology, Foundry, Forming and Welding”, Tata McGraw Hill, ISBN 0 07 4518631.
3. PyeR.G. W., “Injection Mould Design (Design manual for plastic industry)”,EWP
4. Sharma P. C., “Production Engineering”, S. Chand, ISBN 81 219 04218.
5. KempsterM.H.A., “Introduction to Jigs and fixturesdesign”.ISBN8185617856.

Reference Books

1. Joshi P H, Jigs and Fixtures, Tata McGraw Hill, ISBN: 9780070680739
2. J R Paquin, “Die design Fundamentals”, Industrial Press Inc., ISBN 0 8311 11720.
3. Doehler H.H,” Die Casting”, Mc GrawHill
4. Joshi P.H., “Press Tools Design & Construction”, Wheeler Pub., ISBN 8185814465.
5. Dr. Surender Kumar, “Production Engg. Design” (Tool Design), SatyaPrakashan
6. AthalyeA.S., “Plastics Materials handbook”, Multitech Pub. Co.,

Production and Operations Management

311089(A)

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

Prerequisites: Industrial Engineering and Management

Course Outcomes:

Learner will be able to:

1. Analyze implications of Production and Operations Management in industries.
2. Demonstrate the role of Production Management in creating competitive advantage for business organizations.
3. Analyze various constituents of production operations in manufacturing and service.
4. Plan and control various production related activities.
5. Illustrate various inventory management procedures with the tools employed there in.
6. Demonstrate role of JIT, MRP, and ERP with their contribution towards production and operations management.

Unit I: Introduction (6)

An overview of Production and Operations Management (POM), Managing a Production System, Types of Production Systems, Significance of Productivity, Decision making in POM, Problems in POM, Sub functional areas of POM, Recent trends in POM.

Unit II: Product Planning and Development (PPD) (6)

What is a Product?, Need, Objectives and Challenges of PPD, characteristics of Successful Product Development, New Product development Strategy and Process, Factors to be considered in Product Development, The Product Life Cycle Concept, Factors affecting Product Design and Product Development, Stages in Product Design and Product Development.

Unit III: Production Planning and Control (6)

Classification of PPC functions, Factors determining PPC, procedure Role of PPC in POM, Principles of PPC, PPC in different Production System, Organisation of PPC department.

Unit IV: Facility Location (6)

The need for location decision, Procedure for making location decisions, Factors affecting location decisions, Methods of evaluating location decisions (numerical on this topic). Facility Layout / Plant Layout Types of Layout, Significance and Factors influencing layout choices, Principles of Plant layout, Computerized Layout Techniques.

Materials Handling

Function, Importance and Objectives of Material Handling, Material handling Principles, Types of Material Handling Systems, Selection of Material Handling Equipments, Evaluation of Material handling Performance Relationship with Plant layout (numerical on this topic)

Unit V: Inventory Management (6)

Nature, Importance, Classification and Functions of Inventory, Inventory Costs, Importance of Inventory Management, Inventory Control System for Dependent Demand and Independent Demand, Inventory Ordering Systems. Inventory Control

subject to Known Demand. The EOQ Model, Extension to Finite Production Rate,Quantity Discount Model (numerical on this topic).Inventory Control subject to Uncertain Demand, The Newsboy Model, Service Levels in Q and R Systems, (numerical on this topic)

Unit VI: Advance Topics in POM (6)

Material Requirement Planning (MRP) (numerical on this topic), Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Just in Time Manufacturing, Lean Production, Agile Manufacturing, Line Balancing (numerical on this topic), Line of Balance (numerical on this topic), Sustainable Production and Green Manufacturing. Block chain technology for Supply chain monitoring, Materials provenance and counterfeit detection, Identity management, Asset tracking, Quality assurance, Regulatory compliance

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. MartandTelsang, "Industrial Engineering and Production Management", S Chand & Co, New Delhi.ISBN8121917735
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
8. Vinodkumar Garg, "Enterprise resource planning: concepts and practice" by PHI Learning, ISBN: 8120322541, 9788120322547

Process Engineering and Resource Planning

311090(A)

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

Prerequisites:

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

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: Process Engineering (6)

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: Geometric dimensioning and tolerance analysis (6)

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: Work-piece control and selection of operations **(6)**

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: Equipment & Tooling Selection: **(6)**

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: Process Selection and Capacity Planning **(6)**

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 PIanning, 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: Computer aided process planning **(6)**

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.

Elective 2-Product Design and Development

311091(A)-I

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

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Prerequisites: Production Management

Course Outcomes:

After Successful completion of this course students will be able to

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

Unit I: Engineering Product Design (6)

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

Unit II: Embodiment Design (6)

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

Unit III: Product Development Process (6)

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

Unit IV: Identifying Customer Needs (6)

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

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

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

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

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

Text Books

1. Karl T. Ulrich & Steven D. Eppinger., Product Design & Development, M cGraw Hill, 3rd Edition, 2003.
2. Dieter and Schmidt , Engineering Design, McGraw – Hill Higher education, ISBN: 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

Elective 2-Nano Manufacturing

311091(A)-II

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

Course Outcomes

After Successful completion of this course students will be able to

1. Classify different techniques used in micro-nano machining
2. Apply the conventional techniques used in micro-nano manufacturing
3. Select appropriate Non-conventional micro-nano manufacturing and finishing approaches
4. Understand Nanofabrication Techniques and other processing routes micro-nano manufacturing
5. Understand different metrology tools used in micro-nano manufacturing

Unit I:Ultra-precision Machining Processes (6)

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

Unit II: Ultra-precision Forming Processes (6)

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

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

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

Unit IV:Nano Finishing Processes (6)

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

Unit V:Micro-nano Fabrication (6)

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

Unit VI: Micro-nano Measurements (6)

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

Text books:

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.

Reference books:

1. NitaigourPremchandMahalik, Micro-manufacturing and Nanotechnology, 2006.
2. V.K. Jain, Micro-manufacturing Processes, CRC Press, 2012.

3. J. Paulo Davim, Mark J. Jackson Nano and Micro machining, John Wiley & Sons, 2013
4. Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015
5. Kapil Gupta, Micro and Precision Manufacturing, Springer, 2017

Elective 2-Statistics and Numerical Methods

311091(A)-III

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

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

Outcomes: After studying the subjects students will be able to

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

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

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

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

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

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

Errors & approximations: types of errors, error propagation. Numerical solution of algebraic and transcendental equations by bisection method.
Newton Raphson Method. Numerical solution of Linear Simultaneous Equations by Gauss Elimination Method, Gauss-Siedel Method.

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

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

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

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

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

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

Text Books:

1. Douglas C. Montgomery, Design and analysis of experiments, John Wiley and sons inc. New York 8th edition.
2. S.C. Chapra, R.P. Canale, ―Numerical Methods for engineers with programming and software applications, Tata McGraw Hill Co. Ltd, New Delhi, ISBN 0071158952.

Reference Books:

1. Dr. Sadhu Singh, ―Computer aided Design and Manufacturingll, Khanna Publication, New Delhi.
2. Ramin S. Esfandiari, Numerical Methods for Engineers and Scientists Using MATLAB, CRC press, Taylor and Francis group.
3. JaanKiusalaas, Numerical Methods in Engineering with Matlab, Cambridge University press.

Elective 2-Financial Management and Costing

311091(A)-IV

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

Pre-requisites: Industrial Engineering & Management, Production Management

Course Outcomes:

After learning this subject, the student will:

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

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

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

(6)

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.

(6)

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.

(6)

Unit IV: Costing

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 labourcost machining. Overheads: Classification, collection of overheads, Primary and Secondary apportionment of overheads, absorption of overheads. Machine hour and labour hour rate. Under and over absorption of overheads. Estimation of overheads**.**

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

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

Unit VI: Types of Costing Methods **(6)**

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

Text Books:

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

Reference Books:

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

Production Tooling-Lab

311088(B)

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

Term Work:

(All drawings on A2 size drawing sheet)

1. Design and drawing of Jigs and fixtures
2. Design & Drawing of Press tool dies (Progressive/Compound)
3. Design and drawing of Forging die.
4. Design and drawing of injection mold.
5. One practical application of press tool design using software such as VISI Progress, TopSolid Progress etc. and injection mould design using software such as Creo-Plastic advisor, TopSolid Mold, Autodesk Mould design etc.
6. Industrial visit and report

Production and Operations Management Lab

311089(B)

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

List of Experiments:

1. Introduction to Production Systems by arranging machines as per type of Production Systems.
2. Assessment of Layout of Machines based on the time required to complete the product: Selection of Best Layout.
3. Selection of Material handling equipment. Material Handling System Planning and analysis.
4. Inventory Model Implementation for the case of Product.
5. Preparation of Material Requirement Plan for the product selected.
6. Simulation case study based on Production Planning
7. Simulation case study based on line balancing
8. Simulation case study using PLM software to prepare Material Requirement Plan and Product data management

Process Engineering and Resource Planning Lab

311090(B)

Teaching Scheme	Credit Scheme	Examination Scheme
Practical: 2 hours/ week	Practical: 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.

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.

Elective 2-Product Design & Development Lab

311091(B)-I

Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Practical: 2 hours / week	Practical:01	PR: 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

Elective 2-Nano Manufacturing Lab

311091(B)-I

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

Practical assignments:

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

Elective 2-Statistics and numerical methods lab

311091(B)-III

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

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

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

Elective 2-Financial Management and Costing Lab

311091(B)-IV

Teaching Scheme	**Credit Scheme**	**Examination Scheme**
Lectures: 02 hours / week	Pracical: 01	PR: 50 Marks

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

1. Perform Ratio analysis based on financial statement of 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

Fabrication Lab

311092

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

Course outcomes:

Students will be able to

1. Demonstrate practical knowledge for CNC programming, setting tool length offsets/part offset etc.
2. Build products on VMC machines.
3. Implement various aspects of welding process
4. Model and Create products using 3D printing process

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

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

Internship

311093

Teaching Scheme	Credit Scheme	Examination Scheme
	Internship:04	TW: 100 Marks

Course Outcomes:

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

1. To develop professional competence through industry internship.
2. To apply academic knowledge in a personal and professional environment
3. To build the professional network and expose students to future employees.
4. Apply professional and societal ethics in their day to day life.
5. To become a responsible professional having social, economic and administrative considerations.
6. To make own career goals and personal aspirations.

Guidelines:

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

Duration:

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

Internship work Identification:

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

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

- Working for consultancy/ research project,
- Participation at Events (Technical / Business)/in innovation related completions like Hackathon,

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

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

Internship Diary/ Internship Workbook:

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

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

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

Internship Work Evaluation:

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

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

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

Evaluation through Seminar Presentation/Viva-Voce at the Institute

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

- Depth of knowledge and skills Communication & Presentation Skills

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

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

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

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

Feedback from internship supervisor (External and Internal)

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

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

Mandatory Audit Course 6:
Technical writing and communication skill
311094

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

Technical Writing –

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

Communication Skills –

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

Mandatory Audit Course 6:
Energy Auditing and Management in Industries
311094

Course outcomes:

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

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

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

Text Books:

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

Reference Books:

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