Shivaji University, Kolhapur.

STRUCTURE & SYLLABUS FOR B. E. (PRODUCTION ENGINEERING) PROGRAM

Class: S. E. (PRODUCTION ENGINEERING) SEMESTER-III
(TO BE REVISED FROM JULY 2014)

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Machine Tools and Processes	3	1	-	4	3	100	25	-	25	150
2	Engineering Mathematics – III	3	-	1*	4	3	100	25	-	-	125
3	Machine Drawing	2	4	-	6	4	100	25	-	25	150
4	Thermal Engineering	3	2	-	5	3	100	25	-	-	125
5	Electrical and Electronics Engineering	3	2	-	5	3	100	25	-	-	125
6	Object Oriented Programming with C++	2	2	-	4	-	-	25	50	-	75
7	Workshop Practice-III	-	2	-	2	-	-	50	-	-	50
	Total	16	13	1	30	-	500	200	50	50	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work, * Tutorials shall be conducted batch-wise.

Class: S. E. (PRODUCTION ENGINEERING) SEMESTER-IV

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Foundry Technology	3	2	-	5	3	100	25	-	-	125
2	Advanced Machine Tools and Processes	3	1	-	4	3	100	25	-	-	125
3	Theory of Machines-I	3	2	-	5	4	100	25	-	-	125
4	Analysis of Machine Elements	3	2	-	5	3	100	25	-	25	150
5	Welding Technology	3	2	-	5	3	100	25	-	-	125
6	Computer Aided Solid Modelling	1	2	-	3	-	-	25	25	-	50
7	WS Practice-IV	-	2	-	2	-	-	25	25		50
8	Mini Project*	-	1	-	1	-	-	50	-	-	50
	Total	16	14	-	30	-	500	225	50	25	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work,

* Note: For Mini Project, a group of nine students shall be considered for workload purpose.

Shivaji University, Kolhapur.
Class: T. E. (PRODUCTION ENGINEERING) SEMESTER-V

(TO BE REVISED FROM JULY 2015)

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Metallurgy	3	2	-	5	3	100	25	-	-	125
2	Theory of Machines-II	3	2	-	5	3	100	25	-	-	125
3	Design of Machine Elements	3	2	-	5	3	100	25	-	-	125
4	Metrology	3	2	-	5	3	100	25	25	-	150
5	Metal Forming and Plastic Engineering	3	1	-	4	3	100	25	-	-	125
6	Metal Cutting Theory	3	1	-	4	3	100	25	-	-	125
7	WS Practice -V*	-	2	-	2	-	-	25	-	-	25
	Total	18	12	-	30	-	600	175	25	-	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work
*Note: Work load of 2 Hrs. practical per batch to be allotted to the teaching faculty member.

Class: T. E. (PRODUCTION ENGINEERING) SEMESTER-VI

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Industrial Management	3	1	-	4	3	100	25	-	-	125
2	Industrial Hydraulics and Pneumatics	3	2	-	5	3	100	25	-	25	150
3	Design of Jigs, Fixtures and Dies	4	2	-	6	4	100	25	-	25	150
4	Quality Management	3	2	-	5	3	100	25	-	-	125
5	Machine Tool Design	3	2	-	5	3	100	25	-	-	125
6	CAM Laboratory and CNC Workshop Practice	-	4	-	4	-	-	50	50	-	100
7	Research Seminar #	-	1	-	1	-	-	25	-	-	25
	Total	16	14	-	30	-	500	200	50	50	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work
Note: For Research Seminar, a group of nine students shall be considered for workload purpose.

√ Please refer to the important Instructions for Industrial Training & Project Work at the end of T.E.-Prod. Sem-VI syllabus.

Shivaji University, Kolhapur.
Class: B. E. (PRODUCTION ENGINEERING) SEMESTER-VII

(TO BE REVISED FROM JULY 2016)

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Operations Research	3	2	-	5	3	100	25	-	-	125
2	Mechatronic Systems	3	2	-	5	3	100	25	25	-	150
3	Production and Operations Management	3	2	-	5	3	100	25	-	-	125
4	Process Engineering	4	2	-	6	4	100	25	-	25	150
5	Elective-I	3	2	-	5	3	100	25	-	-	125
6	Industrial Training*	-	-	-	-	-	-	25	-	25	50
7	Project Work * Phase-I	-	2*	-	2*	-	-	75	-	-	75
	Total	16	12	-	28	-	500	225	25	50	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work
*Note: For Industrial Training and Project Work a group of nine students shall be considered for workload purpose.

Class: B. E. (PRODUCTION ENGINEERING) SEMESTER-VIII

Sr. No.	Subject	Teaching Scheme Hours/week				Theory Paper Duration Hours	Examination Scheme Marks				Total Marks
		L	Pr	Tut	Total		Theory	TW	Pr	Oral	
1	Costing and Cost Control	3	2	-	5	3	100	25	-	-	125
2	Industrial Engineering	3	2	-	5	3	100	25	-	25	150
3	Finite Element Analysis	4	2	-	6	3	100	25	25	-	150
4	Elective-II	3	2	-	5	3	100	25	-	-	125
5	Elective-III	3	2	-	5	3	100	25	-	-	125
6	Project Work Phase-II #	-	4#	-	4#	-	-	75	-	50	125
	Total	16	14		30	-	500	200	25	75	**800**

L: Lecture, Pr: Practical, Tut: Tutorial, TW: Term Work
Note: For Project Work a group of nine students shall be considered for workload purpose.

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List of Elective Subjects for B. E. (Prod. Engg.) Sem. VII and Sem. VIII

Elective I: (Interdisciplinary Group)

1. Automobile Engineering
2. Energy Engineering
3. Composite Materials and Technology
4. Experimental Stress Analysis
5. Safety Engineering
6. Rapid Prototyping
7. Reliability Engineering

Elective II: (Design and Systems Group)

1. Product Design and Development
2. Advanced Machine Design
3. Advanced Tool & Die Design
4. Material Handling Systems
5. Artificial Intelligence
6. Industrial Robotics
7. Computer Integrated Manufacturing Systems

Elective III: (Management Group)

1. Marketing Management
2. Statistics for Engineering Research
3. Materials Management
4. Project Management
5. Financial Management
6. Entrepreneurship Development
7. Supply Chain Management

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EQUIVALENCE OF OLD & NEW SYLLABI OF S. E.(Prod. Engg.)

Old Examination	Sr. No.	Subject under Old Syllabus	New Examination	Equivalent Subject under New Syllabus
S. E. (Prod.Engg.) Sem. I	1	Engineering Mathematics-III	S. E. (Prod. Engg.)Sem. I	Engineering Mathematics-III
	2	Machine Drawing	S. E. (Prod. Engg.)Sem. I	Machine Drawing
	3	Thermal Engineering	S. E. (Prod. Engg.)Sem. I	Thermal Engineering
	4	Electrical Technology & Industrial Electronics	S. E. (Prod. Engg.)Sem. I	Electrical & Electronics Engineering
	5	Machine Tools & Processes	S. E. (Prod. Engg.)Sem. I	Machine Tools and Processes
	6	Advanced Programming Laboratory	S. E. (Prod. Engg.)Sem. I	Object Oriented Programming with C++
S. E. (Prod.Engg.) Sem. II	1	Advanced Machine Tools and Processes	S. E. (Prod. Engg.)Sem. II	Advanced Machine Tools and Processes
	2	Foundry Technology	S. E. (Prod. Engg.)Sem. II	Foundry Technology
	3	Analysis of Machine Elements	S. E. (Prod. Engg.)Sem. II	Analysis of Machine Elements
	4	Welding Technology	S. E. (Prod. Engg.)Sem. II	Welding Technology
	5	Theory of Machines - I	S. E. (Prod. Engg.)Sem. II	Theory of Machines-I
	6	Computer Aided Solid Modelling	S. E. (Prod. Engg.)Sem. II	Computer Aided Solid Modelling
	7	Work Shop Practice-IV	S. E. (Prod. Engg.)Sem. II	Work Shop Practice-IV

EQUIVALENCE OF OLD & NEW SYLLABI OF T. E.(Prod. Engg.)

Old Examination	Sr. No.	Subject under Old Syllabus	New Examination	Equivalent Subject under New Syllabus
T. E. (Prod.Engg.) Sem. I	1	Metallurgy - I	T. E. (Prod. Engg.) Sem. I	Metallurgy
	2	Theory of Machines – II	T. E. (Prod. Engg.) Sem. I	Theory of Machines-II
	3	Design of Machine Elements	T. E. (Prod. Engg.) Sem. I	Design of Machine Elements
	4	Metal Cutting Technology	T. E. (Prod. Engg.) Sem. I	Metal Cutting Theory
	5	Metal Forming & Plastics Technology	T. E. (Prod. Engg.) Sem. I	Metal Forming & Plastics Engineering
	6	Metrology	T. E. (Prod. Engg.) Sem. I	Metrology

	7	Work Shop Practice-V	----	No Equivalence, Two additional chances to be given
T. E. (Prod.Engg.) Sem. II	1	Metallurgy – II	----	No Equivalence, Two additional chances to be given
	2	Industrial Management	T. E. (Prod. Engg.)Sem. II	Industrial Management
	3	Industrial Hydraulics & Pneumatics	T. E. (Prod. Engg.) Sem. II	Industrial Hydraulics & Pneumatics
	4	Design of Jigs, Fixtures & Dies	T. E. (Prod. Engg.) Sem. II	Design of Jigs, Fixtures & Dies
	5	Quality Management	T. E. (Prod. Engg.) Sem. II	Quality Management
	6	Machine Tools & Product Design	T. E. (Prod. Engg.) Sem. II	Machine Tool Design
	7	Work Shop Practice-VI	----	No Equivalence, Two additional chances to be given
	8	Seminar	T. E. (Prod. Engg.) Sem. II	Research Seminar

EQUIVALENCE OF OLD & NEW SYLLABI OF B. E.(Prod. Engg.)

Old Examination	Sr. No.	Subject under Old Syllabus	New Examination	Equivalent Subject under New Syllabus
B. E. (Prod. Engg.) Sem. I	1	Operations Research	B. E. (Prod. Engg.) Sem. I	Operations Research
	2	Mechatronic Systems	B. E. (Prod. Engg.) Sem. I	Mechatronic Systems
	3	Process Engineering	B. E. (Prod. Engg.) Sem. I	Process Engineering
	4	Production & Operations Management	B. E. (Prod. Engg.) Sem. I	Production and Operations Management
	5	Computer Aided Design & Analysis	B. E. (Prod. Engg.) Sem. II	Finite Element Analysis
	6	Advanced CNC Laboratory	B. E. (Prod. Engg.) Sem. II	No Equivalence, Two additional chances to be given
	7	Vacational In-plant Training Report	B. E. (Prod. Engg.) Sem. II	Industrial Training
B. E. (Prod. Engg.) Sem. II	1	Costing and Cost Control	B. E. (Prod. Engg.) Sem.	Costing and Cost Control

			II	
	2	Computer Integrated Manufacturing Systems	B. E. (Prod. Engg.) Sem. II	Elective II -7. Computer Integrated Manufacturing Systems
	3	Advanced Industrial Engineering	B. E. (Prod. Engg.) Sem. II	Industrial Engineering
	4	E I- Marketing Management	B. E. (Prod. Engg.) Sem. II	E III- 1. Marketing Management
	5	E I- Entrepreneurship Development	B. E. (Prod. Engg.) Sem. II	E III-6. Entrepreneurship Development
	6	E I- Materials Management	B. E. (Prod. Engg.) Sem. II	E III- 3. Materials Management
	7	E I- Data Base Management	B. E. (Prod. Engg.) Sem. II	No Equivalence, Two additional chances to be given
	8	E I- Financial Management	B. E. (Prod. Engg.) Sem. II	E III- 5. Financial Management
	9	E I- Environment & Pollution Control	---	No Equivalence, Two additional chances to be given
	10	E I- Organizational Behaviour	B. E. (Prod. Engg.) Sem. II	No Equivalence, Two additional chances to be given
	11	E II- Flexible Manufacturing Systems	B. E. (Prod. Engg.) Sem. II	EII- 7-Computer Integrated Manufacturing Systems
	12	E II-Artificial Intelligence	B. E. (Prod. Engg.) Sem. II	E II- 5. Artificial Intelligence
	13	E II-Industrial Robotics	B. E. (Prod. Engg.) Sem. II	E II-6. Industrial Robotics
	14	E II-Low Cost Automation	B. E. (Prod. Engg.) Sem. II	No Equivalence, Two additional chances to be given
	15	E II-Material Handling Systems	B. E. (Prod. Engg.) Sem. II	E II-4. Material Handling Systems
	16	E II-Advanced Foundry Technology	B. E. (Prod. Engg.) Sem. II	No Equivalence, Two additional chances to be given
	17	E II-Advanced Tool & Die Design	B. E. (Prod. Engg.) Sem. II	E II- 3. Advanced Tool & Die Design

Shivaji University, Kolhapur.
S.E. (Production Engineering) – Part I, Semester III

1. MACHINE TOOLS AND PROCESSES

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 1 Hr. / Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
External Oral Examination: 25 Marks

Course Objectives:
1) To understand the various conventional and basic machine tools and manufacturing processes carried out on these machines for different applications.
2) To gain the basic knowledge about machine tools and its construction and principles of working.
3) To study different parts of the machine tools used in manufacturing machine shops.
4) To study the detailed assembly of manufacturing machine tools.

Course Outcomes:
The students shall be able-
1) To know different types of machine tools of previous and present era machine tools.
2) To visualize positions of each components of the machine tool.
3) To know the different components and their work contribution through different operations performed on the particular machine tool.
4) To learn to visualize components demanded by the present & advanced machine tools.
5) To plan the process and manufacture the newly designed components for better quality, less time and economy of production.

Unit No.1:- Metal cutting machines & Plain surface Generation

Metal cutting machines: (2)

Hacksaw, circular saw, band saw, abrasive cut off machines (general working)

Plain surface generation: (3)

Shaper, Planer, Slotter- construction, working and applications, Classification & Types of these machines.

Unit No.2:- Study of center lathe

Study of center lathe: (7)

Construction and working, Types of lathe, operations performed – Facing ,Turning, Step turning, Grooving, Undercutting, Taper turning, Eccentric turning, Boring, Thread cutting, Gear train calculations, Use of grinding attachment, Milling attachment

Unit No.3:- Study of Drilling machine & Turret and Capstan lathe

Turret and Capstan lathe: (3)

Construction, working, Types. Types of tool holders, Bar feeding mechanism.

Study of Drilling machine: (4)

Types- Bench, Radial, Pillar machines Construction and working, Operations – Drilling, Reaming, Spot facing, counter boring, Counter sinking, Tapping, Multi-spindle and Gang drilling machines

Unit No.4:- Boring machines:& Broaching machine

Boring machine: (3)

Construction and working of boring machines, work setup and tool mountings, use of boring bar, types of boring – plain, step, recessing.

Broaching machine: (2)

Construction and working of horizontal, vertical pull type and push type Broaching machine Use of broach head and fixtures.

Unit No.5:- Milling Machine: (7)

Construction and working of Column and Knee Milling machine, Types of milling operations up milling, down milling, face milling, end milling, plain end milling, straddle milling, gang milling. Types of milling machines – horizontal, vertical, universal, duplex, triplex, Plano- milling (Classification only). Milling cutters – types and use. Construction and working of head, methods of indexing and applications of dividing head

Unit No.6:- Grinding machines: (7)

Grinding machines and operations - External. Internal, Centre less, Surface grinding, Grinding wheel – elements, nomenclature, types, wheel mounting, wheel dressing, wheel tracing, wheel balancing, grinding wheel balancing.

Term Work:

1. At least two industrial visits to study applications related to the subject and submission of the relevant reports.
2. Center lathes - Calculation and creation of setup for a taper turning exercise. Each group of about five students should create a setup for a different exercise along with submission of schematic sketch and description.
3. Milling machines - Setting up of indexing mechanism on Universal Dividing Head for one exercise (Each group of about five students should create a setup for a different exercise along with submission of schematic sketch and description.

Study of construction, working mechanism and applications of any two of the following

4. Grinding Machines
5. Drilling Machines
6. Shaping Machines
7. Planing Machines

Text Books:

1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd.)
2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, (ELBS)
3. Manufacturing Processes & Systems by Phillip F. Ostwald & Jairo Minoz (John Willey & Sons.)
4. Manufacturing Processes by Begeman Amstead, (Wiley.)
5. Manufacturing Processes by Rusinoff, (Tata McGraw Hill Publishing Co. Ltd.)
6. Advanced Manufacturing Technology by Kalpakjian (Addison Wesley)

7. Manufacturing Technology – Metal Cutting & Machine Tools by P. N. Rao (TMH)
8. Workshop Technology Vol. II by Bawa H. S. (TMH)

Reference Book:

1. Production Technology – HMT Handbook (HMT)
2. Production Technology by Jain Gupta, (Khanna Publishers, New Delhi)
3. Ghosh and A. K. Malik, Manufacturing Science, Affiliated East West Press Pvt. Ltd., New Delhi.
4. H. El Hofy, Fundamentals of Machining Processes, Taylor and Francis, 2006.
5. G. C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Central Book Agency (P) Ltd., Calcutta, 2nd Revised Edition, 2009.
6. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
7. J. A. McGeough, Advanced methods of machining, Chapman & Hall, London, 1st Edition, 1988

Shivaji University, Kolhapur.
S.E. (Production Engineering) – Part I, Semester III

2. ENGINEERING MATHEMATICS – III

Teaching Scheme	**Examination Scheme:**
Lectures : 3 hours/week	Theory Paper (3 Hrs.): 100 marks
Tutorial : 1 hour/week	Term work : 25 marks

Course Objectives:

1) To develop the ability to abstract, logical and critical thinking and to reflect critically upon their work.
2) To study various mathematical tools available for analysis and design of engineering systems.
3) To impart skills to students in statistics, integral transforms, vector calculus, differential equations and numerical solutions to differential equations to devise mathematical solutions for given engineering problems.
4) The student must be able to formulate a mathematical model of a real life and engineering problem, solve and interpret the solution in real world.

Course Outcomes:

After undergoing this course the candidates shall be able to apply the concepts of statistics, integral transforms, vector calculus, differential equations and numerical solutions to differential equations in their professional courses.

After completing this course, the student shall be familiar with and be able to:

1) Solve linear differential equations with constants coefficients and apply them to realistic problems.
2) Find directional derivatives of functions of two or three variables.
3) Apply knowledge of vector differentiation to find curl and divergence of vector fields.
4) Apply probability distributions to find probabilities.
5) Express the given function in Fourier series.
6) Find analytic and numerical solution to partial differential equations.

Unit 1 Linear Differential Equations: (7)

1.1 Linear Differential Equations with constant coefficients Definition, Complementary function and Particular integral (without method of variation of Parameters).

1.2 Homogeneous Linear differential equations.

Unit 2 Applications of Linear Differential Equations with constant coefficients: (8)

2.1 The Whirling of Shafts.

2.2 Mass – spring Mechanical system

2.2.1 Free oscillations

2.2.2 Damped Oscillations

2.2.3 Forced oscillations without damping.

Unit 3 Probability Distributions: (6)

3.1 Random variable

3.2 Binomial Distribution

3.3 Poisson Distribution

3.4 Normal Distribution

Unit 4 Vector Differential Calculus: (6)

4.1 Differentiation of vectors

4.2 Gradient of scalar point function and Directional derivative

4.3 Divergence of vector point function and Solenoidal vector fields.

4.4 Curl of a vector point function and Irrotational.

Unit 5 Fourier series: (6)

5.1 Definition, Euler's Formulae.

5.2 Functions having points of discontinuity

5.3 Change of interval

5.4 Expansion of odd and even periodic functions

5.5 Half range series.

Unit 6 Application of Partial differential equations: (7)

6.1 The Wave Equation.

6.1.1 The method of separation of variables.

6.1.2 Fourier Series solution of wave equation.

6.2 One dimensional heat flow equation

6.2.1 The method of separation of variables.

6.2.2 Fourier Series solution of wave equation.

6.3 The Laplace equation in two dimensional heat flow (Steady State).

6.3.1 Solutions of Laplace equations by the Gauss – Siedel iterative method.

General Instructions:

1. For the term work of 25 marks, batch wise tutorials are to be conducted. The number of students per batch should be as per university pattern for practical batches.

2. Minimum number of assignments should be 8 covering all topics.

Nature of Question paper:

1. There will be two questions carrying 20 marks each and four questions carrying 15 marks each.
2. Each question should have internal option.

Reference Books:

1. A text book of Applied Mathematics: Vol. I, II and III by J. N. Wartikar & P. N. Wartikar, Vidyarthi Griha Prakashan, Pune.
2. Higher Engineering Mathematics by Dr. B. S. Grewal.
3. Advanced Engineering Mathematics by Erwin Kreyszig.
4. Advanced Engineering Mathematics, by H. K. Das (S. Chand Publication.)
5. Advanced Engineering Mathematics, by Merle C. Potter (OXFORD University Press)

Shivaji University, Kolhapur.
S.E. (Production Engineering) – Part I, Semester III

3. MACHINE DRAWING

Teaching Scheme:
Lectures: 2 Hrs/ Week
Practical: 4 Hrs/ Week/ Batch

Examination Scheme:
Theory Paper (4 Hours): 100 marks
Term Work: 25 marks
External Oral Exam: 25 marks

Course Objectives:

1) Understanding, preparation and reading of 2D drawings of various machine parts and assemblies used in industry.
2) To develop primary knowledge of working drawings.
3) To develop skills to produce assembly and detail drawings of machine parts.

Course Outcomes:

1) Read and interpret engineering drawings.
2) Represent machine components using standard conventions.
3) Selection of required fits and tolerances for the designed components.
4) Draft 2D drawings of assembly and details of systems, along with preparation of bill of materials.
5) Free hand sketching of engineering components.

Unit 1

Study of I.S. conventions: (4)

Designation of drawing sheet sizes according to ISO A-series.Title block details and sizes. Screw thread terminology. Various parts of screw threads. Forms of screw threads. Conventional representation of threads [internal & external].Different types of nuts and bolts, studs, set screws, cap screws, lock nuts, washers and split pins. To draw views of hexagonal, square nuts and bolts according to scale. IS conventions for- chamfers, tapped and drilled holes, slope and taper & welded joints, countersunk and counter bores. Conventions for showing different metals and materials on drawing. IS conventions of

different types of gears like spur gears, helical gears, worm & worm wheel, bevel gears and rack & pinion. Conventions of different types of springs like helical spring, disc spring, spiral spring and leaf springs. Conventions for splined and serrated shafts. Conventions for straight & diamond Knurling, broken ends of shafts and rods. I.S. conventional representation of ball and roller bearings. Identification of bearings with reference to manufacturing catalogues.

Unit 2

Dimensioning with tolerances: (4)

Study of Limits, Fits and Tolerances. Hole base and shaft

base system for selection of fits. Selection of class and grade of hole & shaft by using hole base system and shaft base system. Designation of fundamental deviation, types of fits and selection of fits between various parts.

Unit 3

Assembly and details of general units: (4)

Meaning and use of machine drawing. Purpose of making assembly and detail drawings. Classification of machine drawing production drawings, working drawings. Practice in making assembly and detail drawings of units consisting of not more than 8 to10 parts [excluding fasteners], giving dimensions with limits fits and tolerances. (Indicative list for assembly, details drawing) Engine parts and other machine parts – stuffing boxes, cross heads, Eccentrics, connecting rod, Piston assembly, Screws jacks, Machine Vices, Tailstock, Crane hook, Simple drill jig & milling fixture, simple press tool assembly, Tool holders etc.

Unit 4

Free hand sketching: (4)

To draw free-hand proportionate sketches of the machine parts like-

4.1 All types of taper and parallel keys. Flanged coupling, protected type flanged coupling, muff coupling, solid coupling, pin type flexible coupling and universal coupling.

4.2 Flat belt pulleys, V-belt pulleys, rope pulleys and fast and loose pulleys.

4.3 Simple solid bearing, bushed bearing, pedestal bearing, foot step bearing.

Unit 5

Preparation of working drawings: (4)

Preparation of working drawings of units and assemblies using suitable drafting software-

Geometrical requirements like surface finish, flatness, straightness, parallelism, perpendicularity, concentricity, etc. Machining symbols, welding symbols, and other Surface texture, roughness values (Ra) and roughness grade numbers. Introduction to the basics of suitable drafting software.

Unit 6

Interpenetration of solids: (4)

Introduction, interpenetration of prism with prism, prism with cylinder, prism with cone, prism with pyramid, (prism and pyramid limited up to rectangular), cylinder with cylinder , cone with cylinder

Notes:-

1) Components mentioned above to be shown to the students before they draw it for understanding practical applications.
2) The Practicals for unit 5 should be conducted in the computer laboratory.
3) The Drafting Software based questions should not be covered in Theory Exam.
4) The focus should be given on "Reading of Industrial Drawings" by the students and the same should be considered during external orals.

Term Work:

Each candidate has to draw following submission sheets on A-2 size drawing sheets-

1. IS conventions mentioned in topic 1.
2. Drawing details and assembly by taking actual measurements.
3. One sheet showing assembly from given details showing limits, fits. (Given problem of details to be attached and need not be drawn. Extensive practice sheets required)
4. One sheet showing details from given assembly showing tolerances using suitable drafting software. (Given problem of assembly to be attached and need not be drawn).
5. Preparation of working drawings of simple machine parts, showing machining symbols, geometrical requirements, surface finish, welding symbols etc using suitable drafting software.
6. One sheet based on free hand sketching of machine parts mentioned in topic 4.
7. One sheet based on interpenetration of solids.

Oral Examination:

External oral will be conducted based on the term work, suitable drafting software and above syllabus.

Note: The practical sessions for the drafting software shall be conducted in the computer laboratory. Appropriate adjustments should be made in the time table for the said practical sessions.

Text Books:

1. Machine Drawing by N.D.Bhatt, (Charotar Publication, Anand)
2. Machine Drawing by N. Sidheswar, Shastri, Kanaiah, (TMH.)
3. Machine Drawing by K.L.Narayanan., (New Age International Publishers)
4. Machine Drawing by R.K.Dhavan, G.R. Nagpal, (S. Chand & Co.)
5. Machine Drawing by P.S. Gill, (S. K. Kataria, Delhi)
6. Engineering drawing by N. D. Bhatt, (Charotar Publication, Anand)

Reference Books:

1 IS: SP 46- Engineering drawing practice for schools and colleges, BIS Publication.
2. Graphic Science & Design by French, Vierck & Foster (McGraw Hill)
3. Production Drawing: K L Narayana, P Kannaiah,K Venketa Reddy, (New Age International)
4. Machine drawing with Auto CAD Goutam Purohit & Goutam Ghosh, Pearson Edition

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4. THERMAL ENGINEERING

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Theory Paper(3 Hrs): 100 Marks
Term Work: 25 Marks

Course Objectives:

1. To apply the fundamentals of thermodynamics to various power producing and power absorbing devices.
2. To analyze the performance of thermodynamic systems and understand their applications.
3. To understand the basic modes of heat transfer and applications of the same.
4. To understand the use of steam for power generation and process heating.
5. To become familiar with the working of air standard cycles and application of the same.
6. To get acquainted with the basic principles of refrigeration and air-conditioning.
7. To understand the basic concepts of air compressors.

Course Outcomes:

At the end of this course the student will be able to:

1. Implement the laws of thermodynamics to various power producing and power absorbing devices.
2. Comprehend the application of the modes of heat transfer to devices such as heat exchangers.
3. Understand the use of steam for power generation, process heating and relevant calculations for the efficiency of a power plant.
4. Analyze IC engines and evaluate their performance using relevant parameters.
5. To understand the working of refrigeration systems and measure their performance.
6. To get acquainted with air conditioning systems and the determination of physical and thermodynamic properties of gas vapor mixtures.
7. To evaluate an air compressor and the methods of enhancing efficiency (multi-staging)

Unit-1

Thermodynamics (6)

Limitations of the first law of thermodynamics, Second Law, Clausius Statement, Kelvin - Planck statement, Equivalence of the two statements, Corollaries of the second law, Refrigerators and Heat pumps, Reversibility and irreversibility, causes of irreversibilities, Carnot Theorem, Phase property diagram.

Unit-2

Vapour Power Cycles (9)

Properties of steam, Ideal Rankine Cycle, Thermal efficiency,

Nozzles

Flow of steam through Nozzles, critical pressure ratio, maximum discharge, effect of friction, calculation of throat and exit areas, nozzle efficiency, Use of Mollier Chart

Turbines and Condensers
Introduction to steam turbine, Types, Compounding Introduction to condensers, Types

Unit-3
Heat Transfer (5)
Modes and laws of heat transfer, steady state heat conduction, thermal resistance, Insulating materials, Heat Exchangers - Classification and Types

Unit-4
Internal Combustion Engines (8)
Analysis of air- standard Otto, Diesel and Dual combustion cycles, Mean effective pressure, Classification of IC engines, Construction and working of two stroke, four stroke, S.I and C.I engines, Systems for IC engines - Cooling and lubrication system, Governing of IC engines, Performance of IC engines - IP, BP, Thermal efficiency, Specific fuel consumption, Heat balance, Applications and Testing of IC engines.

Unit-5
Compressors (5)
Applications of compressed air, Classification of air compressors, Thermodynamic analysis of single stage and multi stage reciprocating air compressors without clearance volume, Work and power calculations, Volumetric efficiency, FAD, Construction and working of Centrifugal and Axial flow air compressor

Unit-6
Refrigeration and Air conditioning (7)
Applications of refrigeration, Reversed Carnot Cycle, Bell Coleman Cycle, Analysis of Simple Vapour Compression Cycle, Representation on T-S and P-H diagrams, COP and power calculations, Introduction to Vapour Absorption Cycle, Types and properties of refrigerants, Eco-friendly refrigerants,
Psychrometry - basic concepts, terms and processes
Summer, Winter and Industrial Air conditioning Systems.

Term Work:
1. Study of constructional details of boilers.
2. To determine the thermal conductivity of a metallic rod.
3. To determine experimental heat transfer coefficient for natural convection.
4. A trial on IC engine to determine Brake specific fuel consumption (BSFC) and thermal efficiency.
5. A trial on reciprocating air compressor to determine isothermal and volumetric efficiency.
6. Industrial visit to study refrigeration / air conditioning plant and submission of relevant report.
7. Visit to a steam power plant to understand the working of its primary constituents and submission of relevant report.
8. Determination of COP of a vapour compression refrigeration system.

Text Books:
1. Basic and Applied Thermodynamics by P.K.Nag (TMH).

2. Thermal Engineering by R.K. Rajput (Laxmi Publications).
3. Thermal Engineering by P.L. Ballaney (Khanna Publishers).
4. Thermal Engineering by B.K. Sarkar (TMH).
5. Thermal Engineering by Kodandaraman (New Age International Publication).

Reference Books:

1. Thermodynamics - an engineering approach by Y.A. Cengel (TMH).
2. Heat Transfer by Holman J.P (TMH).
3. Basic Refrigeration and Air conditioning by Ananthanarayanan (TMH).
4. I.C. Engines by Mathur and Sharma (Dhanpat Rai and Co.).
5. Heat Transfer by S.P. Sukhatme (Orient Longman).
6. Power Plant Engineering by Domkundwar (Dhanpat Rai and Co.).
7. Basic Engineering Thermodynamics by Rayne Joel (ELBS).

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5. ELECTRICAL AND ELECTRONICS ENGINEERING

Teaching scheme:
Lectures: 3 hrs/week
Term Work: 2 hrs/week

Examination scheme:
Theory Paper: 100 marks
Term Work: 25 marks.

Course Objective :

To obtain necessary and broad knowledge of electric machines and electronics useful in the field of production engineering.

Course Outcome :

1) After completion of this course the students shall be able to make use of electric machines for a certain requirement in production engineering area.
2) The students shall also be prepared to work in interdisciplinary fields.

Unit 1 : (6)

D C Motor: Construction, working, types, back emf, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, 4 point starter, reversal of rotation, Electric braking*(Numerical treatment)

Unit 2: (6)

3 phase induction motor: Construction, working, types, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, star delta starter, DOL starter, autotransformer starter, rotor resistance starter, reversal of rotation, Electric braking*(Numerical treatment)

Unit 3 : (6)

Electric drive and their control – group drive, individual drive, multimotor drive. Selection of a drive for different types of mechanical load(Based on speed-torque variation, based on duty period, active/passive. Determination of power rating of an electric motor for continuous duty-constant load. Speed control* of D.C. motor, Speed control of 3 phase induction motor - voltage control*, VFD control*, rotor resistance speed control, (Numerical treatment)

Unit 4: (6)

Solid state switches- Switching phenomenon in diode, SCR, BJT, IGBT, MOSFET, triac. Electronic controllers* - AC to DC converter(1 quadrant, 2 quadrant, 4 quadrant), Dc to DC converter (1 quadrant , 2 quadrant), DC to AC converter(Inverter) for voltage and frequency control. (Numerical treatment)

Unit 5: (6)

Sensors and transducers- Parameters, Classifications, resistance transducers, inductance transducers, capacitance transducers, proximity sensors, rotary incremental encoder, tachogenerator, ultrasonic flow meter, torque measurement using strain gauge.

Unit 6 : (6)

Electric heating- Construction and working of indirect resistance furnace, salt bath electric furnace, 3 phase direct arc furnace, indirect arc furnace, Ajax Wyatt induction furnace, coreless induction furnace, High frequency eddy current heat treatment. (Numerical treatment) (Topics marked by * are co-related.)

Term Work :

Minimum 8 experiments based on following topics:

1. Speed control of d c motor and 3 phase induction motor
2. Reversal of rotation of d c motor and 3 phase induction motor
3. 4 point starter and induction motor starter
4. Electronic controllers
5. Measurement using sensors / sensor parameters
6. Switching action of s s switches / characteristics of s s switching devices.
7. Energy calculations for electric furnace.
8. Industrial visit to study electric furnace.

Text Books:

1. Electrical Technology (Vol. II)- B. L. Theraja , S. Chand Publ.
2. Utilllization of Electric power- R.K.Rajput, Laxmi Publ.
3. Mechatronics – M D Singh, J G Joshi, PHI
4. Power electronics - P C sen

Reference Books:

1. Electrical power – S. L. Uppal, DBS Publ
2. Mechatronics-Integrated Mechanical Electronic Systems- Ramchandran, Vijayraghavan, Balsundaram, Wiley India.

Instruction to paper setters:
The question paper will contain one question on each unit.

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6. OBJECT ORIENTED PROGRAMMING WITH C++

Teaching Scheme:
Lecture : 2 Hrs./Week
Practical : 2 Hrs. / Week / Batch

Examination Scheme:
Term work : 25 Marks
Practical Exam.: 50 Marks

Course Objectives:
1) To understand basic concepts of C++ language.
2) To develop programming skills using object oriented programming with C++.
3) To develop basic skills of office automation.

Course Outcomes:
1) Student will be able to create program using C++ language.
2) Student will be able to create document, data spread sheet using MS-Excel.
3) Increase in logic development capability of student .

Unit 1. Introduction to C++: (5)
Introduction, Applications of C++, C++ statements, Structure of C++ program, Keywords, Identifiers and Constants, Basic Data Types, User Defined Data Types, Derived Data Types. Arrays - One dimensional and two dimensional.

Unit 2. Functions: (4)
Function types, Recursive function, Function & Arrays, Function with default argument

Unit 3. Pointers, Virtual Function & Polymorphism: (6)
Declaration, Pointer arithmetic, Pointers & functions, Pointers to a function, Pointer & arrays, Virtual Function and Pure virtual function, Function Overloading, Operator Overloading.

Unit 4. Inheritance, File Handling ,Templates and Exception Handling: (6)
Forms of Inheritance, Direct & Indirect base class, Types of derivations (public, private, protected), Opening file, writing data, reading data, closing file, file copy, file opening modes, Templates, Function template, Class template, Exception handling.

Unit 5. Introduction to Data Structures in C++: (4)
Introduction to Stack, Queues and Linked List.

Unit 6. Excel Worksheet: (2)
Use of formulas, functions, graphs, Types of charts, using filters.

Term Work:

1) Development of minimum two Programs on each unit.
2) Development of minimum two data spread sheets.

Note: For Practical Examination: One candidate on one PC terminal.
The practical examination shall include the following points:

1) At least one program in C++ to be compiled and executed
2) Followed by Oral Examination in C++
3) At least one exercise on use of Spreadsheets (eg. Excel)

Text Books:

1) Let Us C++ -Yashwant Kanetkar (BPB Publications)
2) Mastering C++- K. R. Venugopal (Tata McGraw Hill)
3) Programming with C++ -Ravichandran (Tata McGraw Hill)
4) Help Manuals of MS-EXCEL

Reference Books:

1) Object Oriented Programming –E.Balgurusamy (TMH)
2) Programming with C++ --Hubbard (Schaum Series) Tata McGraw Hill
3) Waite Group's Object Oriented Programming in C++, Robert Lafore, Galgotia

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7. WORKSHOP PRACTICE-III

Teaching Scheme:
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Term work: 50 Marks

Course Objective:

To practice basic metal cutting processes and acquire elementary skills.

Course Outcomes:

After completion of this course a student shall be able to perform basic metal cutting processes and acquire elementary skills to produce the specified jobs.

Term Work:
Machine shop – Two jobs (Mating parts).

Job 1- 25 Marks.

Facing, Plain turning, Step turning, External taper turning, External threading, knurling, Parting-off,

Job 2- 25 Marks.

1. Facing, Plain turning, Drilling, boring, Internal threading.
2. Hand forging and grinding of dummy tools.

Note:-

1) Students should prepare setup wise working drawing showing all the details in work diary.
2) Dimensional accuracy is of prime importance.
3) Student must maintain work diary showing regular progress in the semester.
4) Assessment of the term work should be carried out considering the above points.

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1. FOUNDRY TECHNOLOGY

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objectives:

1) Understand the basic casting process, sequence of operations be followed through design of pattern and gating system.
2) Gain fundamental knowledge of various traditional and special casting processes.
3) Understand cause and effect of various defects in casting.
4) Understand optimizing yield though use of casting simulation software

Course outcome*:*

1) Understand activities related to converting raw material in to a finished product.
2) Apply their knowledge of CAD/CAM in designing and manufacturing pattern and dies.
3) Understand means of improving casting yield.

Unit 1 Overview of Metal Casting Technology:
Introduction (2)

- Importance of casting process as a manufacturing process
- Advantages and disadvantages of casting process
- Classification of foundries based on different criteria
- Flow chart describing basic steps & major foundry activities
- Layout of different types of foundries
- Introduction to different ferrous and non-ferrous cast alloys and their applications

Unit 2 Introduction to Foundry Tooling:
Patterns, core boxes and dies. (3)

- Types of patterns
- Material used for pattern making
- Tools for pattern making
- Criteria for selection of pattern material

- Functions of patterns, core boxes and dies
- Design and layout of patterns, core boxes and dies
- Application of allowances and selection of parting line
- Use CAD- CAM in Designing and manufacturing of patterns

Unit 3 Gating and Risering System, Sand Conditioning

(3a) Gating and Risering system (4)

- Components of gating system,
- functions and importance
- design parameters of gating system
- Gating ratio,
- Pressurized and un-pressurized gating systems.
- Risers, functions and modulus.
- Directional solidification,
- Methods of improving casting Yield
- Numerical treatment to be given to design of and gating system and riser design.
- Use of simulation software for designing, optimization of gating, risering.

(3b) Sand Molding, core making: (6)

- Sand mullers and mixers, continuous and intensive mixers, sand slinger
- Sand conditioning and sand reclamation.
- Green sand mixes.
- Ingredients of green sand and their effect on properties of green sand like – Strength, Permeability, Compatibility, Permeability, Wet-tensile, Friability, and Collapsibility.
- Introduction to resin sands – Alkyd resins, Phenolic resins, Furan sands
- Hand molding tools and machine molding machines.
- High pressure line, disamatic (flask less) and shell molding, magnetic molding, vacuum "V" molding process, cosworth molding process, CO2 molding, "N" Process.
- Simple sand mixes for core making,
- Oil sand, cold box processes,
- Shell core making. Core shooters for shell core making and cold box
- Core assembly, Use of core prints and chaplets, Core and mould venting

Unit 4 Special casting technology

Introduction to special casting techniques (4)

- Investment, full mold, ceramic castings and their applications.
- Squeeze casting, vaccume casting, slush casting, Centrifugal casting and Die casting Types and applications

Unit 5 Melting technology

Melting practices (8)

- Types of melting furnaces: Cupola: construction and working of cupola, lining

material, Raw material for melting, Charge calculations (numerical treatment), Latest designs and modifications in cupola melting. Rotary furnaces, Oil fired furnaces. Electric furnaces– Induction and arc furnaces (Construction, working, applications and selection parameters for furnaces)

- Composition, physical properties and applications of ferrous and non-ferrous castings – Grey cast iron, S. G. iron, White cast iron, malleable cast iron, Al,Cu,Mg based alloys.
- Importance and methods of inoculation in cast irons and De-oxidation practices in steel castings.
- Degassing and modification treatments in aluminum, copper and magnesium alloy castings.
- Ladles – Types, Use, Lining materials. Automatic ladle system
- Instruments for process control: Composition tests – CE meter, Wedge test, Fluidity test, Wet chemical analyses, and Spectrometers. Temperature tests – Pyrometers
- Maintenance and energy saving concepts

Unit 6 Post melting operations

Fettling and cleaning of castings (2)

- Knock out, Cutting of in-gates, Risers
- Shot blasting
- Finishing by using pneumatic chippers and grinders
- Salvaging of castings

Defects, inspection and testing of castings (3)

- Casting defects –Analyses and remedies.
- Testing of strength and hardness
- Non-destructive testing of castings-Visual and dimensional inspections, dye penetrant test, magnetic particle inspection, ultrasonic test, Leak test.
- Casting rejection analysis

Heat treatment and painting of castings: (2)

- Purposes, methods.(Annealing, normalizing, hardening and stress relief hardening)
- Age hardening of Al alloy castings
- Painting of castings: Purpose types and methods of painting of castings

Pollution and safety in foundries (2)

- Possible hazards in foundries,
- Safety measures, Safety devices
- Types and sources of pollution in foundries,
- Measures for pollution control

Term Work:

1. Two industrial visits one each to a ferrous and a non-ferrous foundry to study foundry practices and submission of the relevant report.

2. Drawing sheet based on Design of pattern, Pattern layout, Pattern allowances, Selection of parting line, gating and risering system design.
3. Pattern making based on the exercise no. 2 above. (4 practical turns for pattern making job in pattern shop)
4. Study of types and different tests on raw and prepared sand.
5. Sand tests of minimum three types (Sieve analyses, Sand preparation, green/dry Strength, clay content, moisture content, Mould and core hardness)
6. Study of types of molds and cores.
7. At least one simple exercise for pattern making and metal pouring for the same separately for a group of about five students.
8. One presentation of 10 minutes by each student related to the subject and submission of the write up on the presentation. (Optional)

Text Books:

1. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)
2. Metal Casting – Principles & Practice by T. V. Rama Rao (New Age International Pvt. Ltd.)
3. A Text Book on Foundry Technology by M. Lal, O. P. Khanna(Dhanpat Rai & Co.)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Fundamentals of Metal Casting by P. C. Mukharjee (Oxford & IBH Publishing Co).
6. Principles of Foundry Technology by P. L. Jain (Tata McGraw Hill)
7. Foundry Practice by N. D. Titov (MIR)
8. Foundry Engineering by Taylor, Flemings, Wulff (Wiley Eastern Ltd.)
9. Principles of Metal Casting by Heine, Loper, Rosenthal

Reference Books:

1. Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
2. Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
3. Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication)
4. The FOSECO Foundry man's handbook 10^{th} edition by Butter Worth-Heinemann (BH Publication)

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2. ADVANCED MACHINE TOOLS & PROCESSES

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 1 Hr. / Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objectives:

1) To study understand the various nonconventional and CNC machine tools and manufacturing processes carried out on them for different applications.
2) To gain the basic knowledge about Manufacturing Processes for composites material.
3) To acquire the basic knowledge about advanced machine tools and its construction and principles of working.
4) To study various parts of the machine tools used in manufacturing machine shops.
5) To study the constructional design aspect of various engineering machine tools.
6) To study assembly of various machine tools, actual fitments of components / assembly of conventional and present era machine tools.

Course Outcomes:

1) Students will be able to know various kinds of machine tools of previous and present era machine tools.
2) Students will be able to visualize positions of each components of the machine tool.
3) Students will be able to know the different components and their work contribution through different operations performed on the particular machine tool.
4) Students will be able to design/ alternate designs of the same machine tool or different machine tool.
5) Students will learn visualize and design components/ shapes demanded by the present / advanced machine tools.
6) Students will be able to process plan and manufacture the newly designed components of their own design for betterment, lesser time and economy of production.

Unit- 1 Non-Conventional Machining Processes

Non-Conventional Machining: (5**)**

Importance & scope of various non-conventional machining processes like Electro-Chemical machining (ECM), Electro-Discharge machining (EDM), Wire Electro-Discharge machining (WEDM), Abrasive Jet Machining (AJM), Laser Beam Machining (LBM), Ultrasonic Machining (USM**),**Abrasive water Jet Machining (AWJM), Photochemical machining(PCM)

Unit- 2 Gear Manufacturing: (6)

Gear Manufacturing – Different methods of gear manufacturing (for Spur, Helical, Bevel Gears), Casting,

Rolling, Extrusion, Stamping, Powder Metallurgy of Gears, Machining of Gears (Forming, Template generating). Gear finishing by Shaving, Lapping, Grinding, and Burnishing.

Unit- 3 Thread manufacturing processes & Super Finishing processes

Thread manufacturing processes: (3)

Thread Cutting on Lathe, Thread milling, Thread Grinding, Thread Whirling, Thread Rolling, Use of Chasers & Dies for thread manufacturing.

Super Finishing processes: (3)

Working, Scope & Importance – Lapping, Honing, Burnishing, Buffing, Electro polishing, Polishing & allied processes.

Unit- 4 Introduction to Computer Numerical Control & CNC Support Systems

Computer Numerical Control: (5)

Principle of Operation of Numerically controlled (NC) machine tools, control of axis motion, Advantages and limitations, Computer Numerical Control (CNC)– advantages over NC machine tools, Types of controls in CNC:- Point-To-Point (PTP), Para-axial, 2 axis and 3 axis Continuous Path, Closed and Open Loop; CNC elements:- structure, spindle, Drives- DC & AC Servomotors, Stepper Motors, Linear Motors, Lead screws and ball screws, Feedback Devices, Coordinate system and Axis nomenclature

CNC Support Systems: (2)

Automatic Chip removal, Machine control unit (MCU), MCU operation control panel, Benefits, Control program, External inputs, External outputs, Additional programming facility, Communication, Tool Management, Graphic Proving, Concept of a CNC Part Program

Unit- 5 Introductions to CNC Machining Centers & Turning Centers

CNC Machining Centers: (5)

Types and construction:- Vertical-Traveling Column, Gantry type, Multiple spindle; Horizontal, Use of rotary table, Types of Operations on VMC and HMC, Pallets and pallet changers, Tools for machining centers- Tool Holder (Adaptor), Retention knob, Collets, Various cutting tools and materials- HSS, Solid carbide, indexable insert type, Cemented carbide, coated carbide, ceramics, Concept of Tool Presetting, Tool Magazines, Automatic Tool Changer

CNC Turning Centers: (4)

CNC Lathes, Types and construction, Slant bed, Vertical, Twin turret, Multiple Spindle; Tool Turret, Feed and indexing, Turn-mill centers, Live spindle tool adaptors, Types of operations on Turn-mill centers, Coordinate system for CNC lathes, Work Holding, Tools for CNC Lathes, ISO coding system for turning tools and inserts

Unit- 6 Rapid manufacturing & Composite material:

Rapid manufacturing: (2)

Definition of rapid manufacturing, Process overviews, Sterio lithography, Selective Laser Sintering, Fused deposition modeling, Laminated object manufacturing, Laser powder forming.

Composite material: (3)

Definition of composite material , Classification, Application, Merits and Demerits. Manufacturing Processes for composites such as hand lay, filament winding, pultrusion, RTM.

Term Work:

(To be assessed on the basis of Submission of Report of the following assignments)

1. Thread manufacturing: Calculation of Gear Trains for three different pitch values-Single and Double Start.
2. Industrial visit to study Thread Cutting and Super finishing Processes
3. Industrial Visit to study Gear manufacturing Processes, (Gear cutting on Milling/ Shaping /Hobbing, Gear Grinding)
4. Industrial visit to study Construction, Operation and accessories of VMC, HMC and Turning centers

Text Books:

1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd. Mumbai)
2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, (ELBS)
3. Production Technology by Jain, Gupta, (Khanna Publishers, New Delhi)
4. Manufacturing Processes by Begeman Amstead, (Wiley.)
5. Manufacturing Processes by Rusinoff, (Tata McGraw Hill Publishing Co. Ltd.)
6. Fundamentals of Modern Manufacturing – Materials, Processes & Systems (2/e) by Grover, Mikell P. (John Wiley & Sons)
7. Advanced Manufacturing Technology by Kalpakjian (Addison Wesley)
8. Manufacturing Technology – Metal Cutting & Machine Tools by P. N. Rao (TMH)
9. Workshop Technology Vol. II by Bawa H. S. (TMH)
10. CAD / CAM- Principles & Application (2/e) by P. N. Rao (TMH)
11. Computer Numerical Control - Machining & Turning Centers by Quesada & Jayapoovan (Pearson)
12. CNC Machines – M. Adithan, B.S.Pabala (New Age International Publication)

Reference Books:

1. Production Technology – HMT Handbook
2. Production Technology by Jain Gupta, (Khanna Publishers, New Delhi)
3. Ghosh and A. K. Malik, Manufacturing Science, Affiliated East West Press Pvt. Ltd., New Delhi, 2008.
4. H. El Hofy, Fundamentals of Machining Processes, Taylor and Francis, 2006.
5. G. C. Sen and A. Bhattacharyya, Principles of Machine Tools, New Central Book Agency (P) Ltd., Calcutta, 2nd Revised Edition, 2009.
6. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
7. J. A. McGeough, Advanced methods of machining, Chapman & Hall, London, 1st Edition, 1988
8. Non Conventional Machining Processes – Prof. P.K.Mishra (IIT, Kharagpur)
9. Rapid Manufacturing: An Industrial Revolution for the Digital Age – Editors N. Hopkinson, R.J.M. Hague and P.M. Dickens, (2006) John Wiley & Sons, Ltd., ISBN-10 0-470-01613-2
10. R.F. Gibson, Principles of Composite material mechanics, McGraw-Hill, Inc, Newyork, International edition 1994.
11. Robert M Jones, Mechanics of composite material, Taylor & Francis 2nd edition, Newyork, Indian Print 2010
12. G. Benedict, Nontraditional manufacturing processes, Marcel Dekker, New York, 1st Edition, 1987.
13. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, 1st Edition, 2001.

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3. THEORY OF MACHINES – I

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	Theory Paper (4 Hrs):100 Marks
Practical: 2 Hrs/Week/Batch	Term work: 25 Marks

Course Objective:

1) To be familiar with common mechanisms used in machines and everyday life.
2) To provide basic concept of kinematics and kinetics of machine elements.
3) To develop the ability to understand the concepts of mechanisms and the kinematic analysis of mechanisms.
4) To study basics of power transmission.

Course Outcomes: The student shall be able to:

1) Define various components of mechanisms.
2) Construct/Compose mechanisms to provide specific motion.
3) Draw velocity and acceleration diagrams of various mechanisms.
4) Construct CAM profile for the specific follower motion.
5) Select appropriate power transmission mechanism.

Unit 1

Introduction: (4)

Theory of machines – scope, definitions-machine, mechanism, link, kinematic pair, degrees of freedom, mobility criteria, classification of kinematic pairs, conversion, inversion and expansion of mechanism, study of four bar chain, single slider and double slider crank chain and is inversions.

Unit 2

Kinematic Analysis of Mechanisms:

2.1 Velocity Analysis (6)

Concept of position, displacement and velocity of a point and link of a given mechanism, Kinematic analysis of mechanisms by - Relative velocity method, graphical method, (mechanisms up to 6 links) Instantaneous Center method, (mechanisms up to 4 links) (Numerical treatment)

2.2 Acceleration Analysis (6)

Concept of acceleration of a point and link of a given mechanism, Kinematic analysis of mechanisms by Relative method, graphical method, Corioli's Component of Acceleration , Klein's construction (Numerical treatment)

Unit 3

Simple Mechanisms: (4)

Condition for steering, Ackerman's steering mechanism, Davis steering mechanism, Hooke's Joint, Ratchet mechanism, Geneva mechanism. (Numerical treatment on Hooke's Joint)

Unit 4

Cam and Follower: (4)

Classification of cam and follower, Follower displacement, Simple Harmonic Motion, Constant Velocity, Uniform Acceleration and Retardation, Cycloidal motion, Graphical layout of cam, cam with specified counters.

Unit 5

Friction: (4)

Friction, friction between screw and nut, square thread and v threads, friction in turning pairs- slider crank chain, four bar chain, friction at pivot and collar bearings uniform pressure and uniform wear theory, Greasy friction , Film Friction or Viscous Friction, Study of friction clutches. (Numerical treatment expected)

Unit 6

Belt, Rope, Brakes and Dynamometers: (5)

6.1 Belt Drives: Types of Belt and rope drive, angular velocity ratio, effect of belt thickness, effect of slip, length of belt, angle of contact, angle of lap, law of belting, crowning of pulley, limiting tension ratio, power transmission, centrifugal tension in the belt and its effect on power transmission, initial tension and its effect on power transmission. Creep of belt (Numerical treatment expected).

6.2 Brakes and Dynamometers: (5)

Introduction, External Shoe Brakes, Block Brakes, Double Shoe Block Brake, Internal Shoe Brake, Band Brakes, Band and Block Brake, Heat Generated in Braking.(Numerical treatment expected on Brakes) Dynamometers, Absorption Dynamometers & Transmission Dynamometers.

Term Work:

1) At least seven experiments from the following list.

1. Study of machine and mechanisms.
2. Velocity analysis. - By Instantaneous Center method
3. Velocity and Acceleration analysis. - By relative method.
4. Study of mechanisms with lower pairs.
5. Graphical layout of cam profile.
6. Study of friction clutches.
7. Study of dynamometers.
8. Study of Belt and Rope Drive.

And

2) At least one industrial visit to study applications related to the subject and submission of the relevant report.

Text Books :

01. Theory of Machines and Mechanisms, by P. L. Ballaney, (Khanna Publishers, Delhi)
02. Theory of Machines, by S. S. Ratan, (TMH)
03. Theory of Mechanism and Machines by Ghosh and Mallik (EWP)
04. Theory of machines, by Dr. R.K.Bansal, Laxmi Publication
05.Theory of Machines by R.S. Khurmi S.Chand and co.

Reference Books:

01. Theory of Machines, by Thomas Bevan, (CBS Publishers, Delhi)
02. Theory of Machines &Mechanisms,John Uiker, Garden Pennock & Late. J. F. Shigley,

03. Theory of Machines, by W. Green,
04. Kinematics of Machines by R T Hinckle (Prentice Hall Inc.)
05. Kinematics by V.M. Fairs (McGraw Hill)
06. Mechanism Design: Analysis and Synthesis Vol. I by A. Erdman and G.N. Sander (Prentice Hall)
07. Kinematics and Dynamics of Planer Mechanisms by Jeremy Hirsihham (McGraw Hill)
08. "Machines and Mechanisms Applied Kinematic Analysis", David H. Myszka, Pearson Edu, Asia.
09. "Design of Machinery", R. L. Norton, McGraw-Hill.

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4. ANALYSIS OF MACHINE ELEMENTS

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
External Oral Examination: 25 Marks

Course Objectives:

1) To study different type of stresses induced in structural parts due to loading conditions.
2) To study stress distribution diagram for various cross-sections.
3) To study different types of failures due to stresses induced and deflection.

Course Outcomes:

1) Student should able to calculate direct and indirect stresses induced due to loading conditions.
2) Student should able to select best cross-section according to stress distribution diagram.
3) Student can optimize cross-section and length from design point of view.

Unit-1: Concept of stress, strain and strain energy (9)
Types of loads, Stress, Strain, Stress – Strain diagrams, factor of safety, failure stress, working stress, Modulus of Elasticity, Rigidity, Bulk Volume, relations, Hook's law, Poisson's ratio. Strain energy: strain energy due to axial forces, strain energy in bending.

Unit-2: Shear Force and Bending Moment Diagram (7)
Shear force & Bending moments, Shear force and Bending moment computation and diagrams and diagram for statically determinate beams. Application for transverse point loads, UDL, UVL, Intermediate couples on simply supported and cantilever beams. Locating the place of contraflecture and maximum bending moments.

Unit-3: Stresses in beams (9)
Theory of Bending, Flexural formula for straight prismatic beams, Role of Moment of Inertia, for economic use of materials, Neural Axis, Section modulus, moment of resistance, stresses due to bending, beams of uniform strength. Shear stresses in beams due to bending loads, Distribution of shear stresses across plane sections used for common structural purposes.

Unit-4: Direct and bending stresses (4)

Direct and Bending stresses: Axial loading combined with bending, eccentric loading on plane sections, core of section, middle third rule, applications to the problems of crane hooks, machine columns, brackets etc.

Unit-5 Deflection of beams (6)

Deflection of statically determinate beams due to bending loads, Macaulay's method. Application for simply supported and cantilever beams. Struts subjected to axial loading, end connections, Empirical design formulae, Euler's and Rankine's methods.

Unit-6: Principle stresses and principle planes (5)

Principal stresses and planes, general equations for direct stresses in mutually perpendicular directions along with shear stress, Mohr's circle, determination of maximum shear stress and their planes.

Term Work:

The term work will consists of following assignments:

1. Computation of Shear force & Bending moment.
2. Computation of bending stresses.
3. Computation of shear stresses
4. Problems on deflection and slope
5. Axially loaded struts and columns.
6. Problems on principal stresses
7. Problems on Struts.

Instructions for oral examination:

1. Oral examination is based on simple concepts like stress, strain, plotting of stress distribution diagrams.
2. Oral examination is also based on practical implementation of Strength of Materials to Mechanical Engineering problems.

Text Books:

1. Ferdinand P Beer and E.R. Johnston JR. John Dewolf, Mechanics of Materials 3/e,McGraw Hill
2. Timoshenko and Young. Elements of Strength of Materials, East-West Press. Pvt. Limited, New Delhi.
3. Ramamurthum, Strength of Materials, Dhanpat Rai and Sons, New Delhi.
4. Rajput, Strength of Materials, Laxmi Publication
5. S.B Junnerkar. Mechanics of structure Vol I, Publication House
6. Bansal, Charotor Strength of Materials, Laxmi Publication
7. Khurmi Gupta, Strength of Materials, S. Chand Publication.
8. E.P.Popov "Mechanics of Materials" Prentice Hall Inc.
9. Andrew P. & Singer F.L., "Strength Of Materials", Harper & Row Publishers
10. G.H. Rider. "Strength of Materials ", Mac Millan India Ltd.

11 Mechanics of Materials Hibbler 2e Pearson Education Publication

Reference Books:

1. Den Hartong, Strength of Materials, McGraw Hill, New York.
2. H. BURR and John Cheatam, Mechanical Analysis and Design, PHI, New Delhi.
3. Robert Norton, Machine Design, Prentice Hall

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5. WELDING TECHNOLOGY

Teaching Scheme:
Lectures: 3 Hrs/ Week
Tutorial: 2 Hr/ Week/ Batch

Examination Scheme:
Theory Paper (3 Hours): 100 marks
Term Work: 25 marks

Course Objectives:

1) To gain knowledge of various types of conventional & non conventional welding processes
2) To gain knowledge of various prerequisites; critical parameters of welding process
3) To gain knowledge of selection the appropriate welding process
4) To gain knowledge of selection of appropriate welding equipment, welding electrode, flux, type of flame, filler material
5) To gain knowledge of causes of defects generated during welding process; remedies to control defects and various inspection & testing methods

Course Outcomes:

1) Students will be able to know the basics of various conventional & non conventional Welding Processes
2) Student will be able to understand advantages & limitations of welding processes and select the appropriate welding process based on application ; customer requirement and specifications
3) Student will demonstrate an ability to design of welding fixtures as per requirement and specifications.
4) Student will demonstrate an ability of inspection and testing of welded components.
5) Students will be able to know the various aspects of estimation & costing of Welding jobs

Unit 1. Fundamentals and Classification of Welding Processes. (3)

Introduction, classification of Welding processes. Comparison with other joining processes, advantages, disadvantages, practical applications. Welding Symbols. Basic & supplementary weld symbols, types of weld Joints, Selection of Weld Joint, and edge preparation.

Unit 2. Arc Welding Processes and Equipments (6)

Definition, types of processes, Carbon Arc Welding, Flux Shielded Metal Arc Welding, Submerged Arc Welding, Tungsten Inert Gas Welding, Metal Inert Gas Welding, Electroslag Welding, Electro Gas Welding, Plasma Arc Welding , Arc Welding equipments, Electrodes Types, classification and coding of electrodes.

Unit3. (3a) Gas Welding (3)

Principle of operation, types of flames, Gas welding Techniques, filler material and fluxes, Gas

welding equipments, advantages and applications

(3b) Resistances welding: (3)

Definition, Fundamentals, variables advantages and application, Spot Welding, Heat Shrinkage, Heat Balance Methods, Equipment, Electrodes, Seam, Projection Butt (up sets and flash), Percussion Welding – Definition, Principle of Operation, equipment, Metal Welded, advantages and application.

(3c) Soldering and Brazing (3)

Definition, Comparison of Soldering, Brazing and Welding, principle, joint design, filler alloy, fluxes, processes and application.

Unit 4. (4a) **Introduction to Solid State Welding Processes** (3)

Cold Welding, Diffusion Welding, Ultrasonic Welding, Explosive Welding, Friction Welding, Inertia and Forge Welding – Definition, principle of operation advantages, limitation and application.

(4b) Thermal Cutting of Metal (2)

Oxy-Fuel, Oxygen-Lance, Metal Powder, Chemicals Flux Cutting, Arc Cutting- Metallic, Air-Carbon, Tungsten Arc, Plasma Arc Cutting

Unit 5. (5a) Weldability: - (2)

Definition, effect of alloying elements, Purpose and types of tests, Hot Cracking, Root Cracking and Cold Cracking Tests.

(5b) Weld Defects & Welding Distortion:- (2)

Common Weld defects, Causes and remedies. Concept of distortion, Types of distortion, Control of welding distortion

(5c) Inspection and Testing of Welds (4)

Destructive testing of weld – Tensile, Bend, Impact, Nick Break, Hardness, Etch Tests, Non Destructive Testing of Welds – Visual, Leak, X- ray and Gamma ray Radiography, Magnetic Particle Inspection, Dye, Fluorescent Penetrant Tests, Ultrasonic Inspection & Eddy Current Testing

Unit 6. (6a) Welding Automation and Robotics:- (3)

Introduction, Automation options, Simple Mechanization, Dedicated and Special Purpose Automation, Robotic welding, Modular Automation, Programmable control, Remote Control Slave and Automated Systems

(6b)Welding Fixtures (3)

Introduction, welding fixtures, their characteristics, classification and selection considerations, Principles governing design of good welding fixtures, various types of welding fixtures.

(6c)Estimation of Welding Cost (2)

Introduction, main components costs of welding processes, factors involved in welding costs, basic costing procedure for arc welding, basic costing procedure for gas welding, factors affecting welding costs.

Term Work:

The Term Work shall consist of any 5 assignments out of first seven listed below.
Assignment No.8 & 9 are compulsory.

1. One Job- Butt Joint or Lap Joint by Manual Metal Arc Welding
2. One Job- Edge or corner or T Joint by Manual Metal Arc Welding
3. One Job – by using TIG or MIG welding
4. One Job – by using Gas Welding
5. One Job by using Resistance Welding
6. One Job by using soldering Method
7. Study of selection of Welding Processes
8. Design of welding fixture
9. Minimum one Industrial Visit to study advanced welding processes & submission its report.

Text Books:

1) Welding Technology –O.P. Khanna (Khanna Publisher)
2) Welding & Welding Technology-by Richard Little (TMH)
3) Welding Technology –N.K.Srinivasan (Khanna Publisher)
4) Welding Processes and Technology by Dr. R.S.Parmar (Khanna Publisher)

Reference books:

1) Welding Science & Technology by Md. Ibrahim Khan (New Age International)
2) Welding Technology & Design by V.M.Radhakrishnan(New Age International Publisher)
3) Welding Guide and Handbook by- James E Brambaugh (Taraporwala Mumbai)
4) Welding by A.L. Davies – (Cambridge University Press.)
5) Welding Process Technology – P.T.Houltcroft (Cambridge University Press.)
6) Principles of Welding Technology- by L.M.Gourd (ELBS)
7) Advanced Welding systems- Vol..I ,II and III by Jeam Cornu (Jaico Publishing)
8) Arc and Gas welding- V. Rybakav (Mir Publication)
9) Practical Welding Technology- Rudy Molher (Industrial Press Inc.)
10) Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)

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6. COMPUTER AIDED SOLID MODELING

Teaching Scheme:
Lectures: 1 Hr/ Week
Practical: 2 Hrs / week/Batch

Examination Scheme:
Term Work: 25 Marks
External Practical Examination : 25 Marks

Course Objectives:

1) To understand concepts of CAD, and its benefits and applications
2) To understand the concept of 3D modeling and its applications in the areas of CAM & CAE
3) To create solid models, Surface models, assemblies and drafting of a part by using suitable 3D modeling software.

Course Outcomes:

1) Students shall be able to generate 3D solid models using suitable 3D modeling software.
2) Students shall be able to generate Surface models using suitable 3D modeling software.
3) Students shall be able to generate assemblies of simple industrial components using suitable 3D modeling software.

1. **Introduction to CAD:** (1)
   Need for implementing CAD, Application of CAD and its benefits, Hardware Requirements, Different Software packages used for 3D Modeling. Concept of feature based and parametric modeling.

2. **Sketching:** (2)
   2D sketching of elements like line, circle, arc, spline etc. Dimensioning these elements, Geometrical constraints like parallel, perpendicular, co-incident, vertical, horizontal, tangent, symmetric etc.

3. **Generation of Solid models of any five components** (4)
   (Preferably 03 industrial drawing with G; D and T annotations) using any suitable 3D modeling software package. Import and export of 3D solid models between two different software packages. Physical properties like volume, surface area, center of gravity etc of solid model.

4. **Introduction to Surfacing:** (3)
   Generation of surface models of any three simple components using any suitable 3D modeling software..

5. **Assembly Modeling:** (2)
   Concept of Bottom up and top down approach, Building two composite assemblies of components (consisting at least five components) along with all relevant details, Exploded Views using assembly features in any suitable 3D modeling software.

6. **Generation of 2D Drawings:** (2)
   Generation of Orthographic views of individual components required for shop floor [working drawings] from 3D model which will include all relevant views like front, side, top, bottom views, sectional views, dimensioning, dimensional and geometrical tolerances etc. Generation of title block in sheet. Orthographic views of assembly drawings, generation of Bill of Materials (BOM). Plotting of drawings.

Term Work:

1. Creation of at least 5 solid models using solid modeling features available in any suitable 3D modeling software package.
2. Creation of at least 3 surface models using surface modeling features available in any suitable 3D modeling software package.
3. Creation of 2 assembly models of at least 5 parts of different geometry.
4. Generation of 2D (Orthographic) drawings for shop floor using above solid models and surface models.
5. Generation of 2D (Orthographic) drawings of above assemblies along with exploded views
6. Retrieving physical properties for different component materials.
8. Plotting of above drawings on sheet.

Notes:

1. Multimedia projection facility shall be used during lecture sessions along with computer facility
2. For term work no. 1 & 2 above A4 size sheets are to be used for printouts.
3. For term work no. 3 above A3 size sheets are to be used for printouts.
4. for conduction of practical sessions one computer terminal per candidate shall be used

Practical Examination:

Creation of solid model and generation of 2D views from the given part drawing followed by oral assessment based on above term work. (one computer terminal per candidate.)

Reference Books:

1. Various 3D modeling Software Manuals.
2. CAD / CAM, Theory and Practice by Zeid, (TMH)
3. CAD / CAM, Principles & Applications by P. N. Rao (TMH)

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7. WORKSHOP PRACTICE – IV

Teaching Scheme:
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Term work: 25 Marks
External Practical Examination: 25 Marks.

Course Objective:

To practice basic metal cutting processes and enhance the skills.

Term Work :

One composite job consisting of three to four parts employing operations on lathe in addition to profile turning and eccentric turning and operations on Milling, Drilling Demonstration of Grinding operation on Grinding Machine.

Note:-

1) Students should prepare setup wise working drawing showing all the details in work diary.
2) Dimensional accuracy is of prime importance.

3) Student must maintain work diary showing regular progress in the semester.
4) Assessment of the term work should be carried out considering the above points.

Practical examination of Six hours duration should be conducted under the supervision of external examiner and should consist of preparation of job involving operations based on Workshop Practice-III and workshop practice-IV and the assessment of the job by the external examiner.

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8. MINI PROJECT

Teaching Scheme:
Practical: 1 Hrs/Week/Batch

Examination Scheme:
Term work: 50 Marks

Course Objective:
To encourage hands-on working skills by fabricating simple working mechanisms illustrating technical principles.

Term Work:
A group of maximum four students will design and fabricate one simple working mechanism involving mechanical or electromechanical components / sensors. Mechanisms already proven may also be taken up.
For example : Gear trains, shaft bearing assembly, mechanisms with lower and higher pairs, water level indicator, Screw jack etc.

Assessment scheme:

Fabrication of model and presentation	:	40 marks
Report (5 – 10 pages, typed on A4 sheets)	:	10 marks
	Total :	**50 marks**

Reference Books:
1. Machines and Mechanisms (Mir Publications, Moscow)
2. School Projects

OR

2. A group of maximum four students will carry out disassembly of a product comprising of 5 to 10 components; prepare the drawings of the components and reassemble the components to the final product so that it is again in working condition. The report of this work should consist of part drawings and engineering aspects of each part and the assembly.

Assessment scheme:

Disassembly or assembly and understanding with presentation	:	40 marks
Report (5 – 10 pages, typed on A4 sheets)	:	10 marks
	Total :	**50 marks**

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T.E (Production Engineering) – Part I, Semester V

1. METALLURGY

Teaching Scheme:	**Examination Scheme:**
Lecture 3 hrs/week	Theory Paper (3 Hrs.): 100 Marks
Practical 2 hrs/week	Term work 25 Marks

Course Objective:
To study the structures, compositions, properties, applications of various Ferrous and Non Ferrous materials and to Study various heat treatment processes for different engineering materials and various surface treatments processes.

Course Outcome:
The students shall have the knowledge of structures, compositions, properties, applications of various Ferrous and Non Ferrous materials and various heat treatment processes for different engineering materials and various surface treatments processes.

Unit-1 Introduction to Metals and alloy system (8)

- Introduction of Materials: Classification metals, alloys, ceramics, polymers and composites types, properties and applications
- Crystallography - Unit Cell, study of crystal structures of S.C., B.C.C., F.C.C. and H.C.P, Average number of atoms per unit cell, A.P.F. only.
- Nucleation and growth, coring and dendrite structure
- Concept of phases, constituents (components) and degree of freedom
- Phase rule and lever rules
- Construction of phase diagram using cooling curves
- Equilibrium diagrams for Isomorphous systems, Eutectic system, Eutectoid, Peritectic and explanations of cooling of an alloy from liquid state to room temperature.
- Solid solutions and its types, Intermediate phases: electron compound, interstitial compounds

Unit 2 Study of ferrous equilibrium diagrams, with respect to compositions, properties and applications for following alloys (7)

Fe-Fe3C Equilibrium diagram-plain carbon steels,

- Effect of carbon on structure and properties,
- Free cutting steels, Alloy steels ,Tool steels, Stainless steels, Heat resisting steels, HSLA steels, Low temperature alloys, Invar, Hadfield steel, Spring steel

Cast Irons - Fe-C Equilibrium Diagram,

- Factors Affecting Structure of C.I.(graphitization), C.E of cast iron,
- Alloy C.I., Ni-Hard, modified Ni- Hard and Ni-Resists,
- Wrought Iron

Unit 3 Study of non-ferrous equilibrium diagrams, compositions, properties, applications and specifications of important alloys (3)

- Copper-based alloys – (Cu-Ni, Cu-Zn, Cu-Sn, Cu-Be)
- Aluminum-based alloys - Al-Cu: Duralumin, Al-Si: modification treatment
- Titanium-based alloys - Ti-Al, Ti-Mn
- Non-ferrous equilibrium diagrams - Pb-Sn : solders, Sn-Sb : Babbit

Unit 4 Introduction and Principles of Heat Treatment Processes of Steels , Heat treatment furnaces, atmospheres, defects and energy economy (8)

- Introduction to heat treatment: Definition of Heat treatment, process, purpose and process variables.
- Transformation of Pearlite into austenite upon heating.
- Transformation of austenite into Pearlite, Bainite and Martensite on cooling.
- TTT and CCT Diagram and significance, Effect of alloying dements on TTT diagram and its significance.
- Heat treatment furnaces, control systems, equipments, furnace atmospheres.
- Heat treatment defects: - causes and remedies.
- Energy economy in heat treatment through change in material, heat treatment practice and processes.

Unit 5 Heat treatment process of steels , cast iron and Non ferrous alloys. (11)

Heat treatment process of steels –

- Annealing and Normalizing - Classification and application of processes comparison between annealing and normalizing
- Hardening -Hardening process, factors affecting hardening process, hardenability, factors affecting hardenability, determination of hardenability, hardening methods
- Tempering - Purposes of tempering, types of tempering, structural changes during tempering, secondary hardening, temper brittleness.
- Heat treatment process of Cast Irons –Stress relief annealing, normalizing, hardening, surface, hardening and malleablising, annealing.

Surface and case hardening processes:

- Case Hardening
- Carburizing: Pack , liquid and gas carburizing
- Nitriding : Liquid and gas nitriding, plasma nitriding
- Surface Hardening: Flame hardening, induction hardening, electron beam hardening and laser hardening, advantages and limitations
- Case depth measurement - hardness method, chemical method, microstructure method.
- Introduction to heat treatment process carried out on Cu, Al, Mg and Ti metals

and alloys.

- Precipitation Hardening: Basic requirements of alloys that can be precipitation Hardened Precipitation hardenable ferrous and non ferrous alloys and their application.
- Steps in the process of precipitation hardening-Solutionizing, quenching ,aging
- Effects of variables like aging time, temperature, cold working, impurity alloy composition etc. on properties of precipitation hardenable alloys
- Mechanism of Precipitation Hardening- Coherent lattice theory and G.P Zone theory.

Unit 6 Powder Metallurgy. (3)

- Importance of powder metallurgy as a manufacturing technique, advantages and limitations of powder metallurgy
- Methods of powder manufacture, characteristic and testing of metal powders, powder conditioning - heat treatment, blending and mixing.
- Powder compaction - Methods of compaction, compaction pressures, types of compaction, property changes during compaction.
- Sintering - Types of sintering, structure and property changes during sintering, sintering atmospheres and their importance.
- Finishing operations - Sizing, heat treatment, surface treatment, electroplating and impregnation treatments.
- Applications - Self lubricating (porous) bearings, electric contact materials, filters, magnets, sintered friction materials, cutting tools and cermets, flow charts for manufacturing of above components.

Term Work:

The term work shall consist of performance of the following experiments:

1. Study of Metallurgical microscope, construction , its working and need for microscopy
2. Metallography – preparation of specimen and study of mounting
3. Study of microstructure of Low, medium and high carbon steel
4. Study of microstructure of cast iron(Gray, White, Malleable and S.G cast iron)
5. Study of microstructure of Non-ferrous alloys(70-30,60-40 brass, bronze and babbits)
6. Study of heat treatment furnaces

Text Books and Reference Books:

1. Vijendra Singh. Engg. Physical Metallurgy, Standard Publishers, Delhi
2. V.D. Kodgire, Material science and metallurgy, Everest Publishers Pune
3. S.H.Avner, Physical Metallurgy, TMH publication.
4. Rollson , Metallurgy for Engg. Technicians, English language Book Society
5. Clerk, Verney, Engineering Metallurgy' -.
6. Higgins R. A., Hodder, Engineering Metallurgy I and II, English language Book Society.
7. T.V. Rajan & C.P. Sharma, Heat Treatments Principles & Practices, PHI.

8. Prabhudev, Heat treatment of Steels, HMT Handbook
9. A.K. Sinha, Powder Metallurgy
10. G.E. Dieter, Mechanical Metallurgy, Tata McGraw-Hill, New Delhi.
11. Engineering Physical Metallurgy - Lakhtin, C.B.S. Publishers & Distributors
12. Heat treatment of Metals – B. Zaharov, C.B.S. Publishers & Distributors India
13. Material science and Metallurgy, C. Daniel Yesudin, D. G. Harris Samuel Scitech
14. Material Science And Engineering , Callister Wiley India Edition
15. Study of heat treatment processes of steels (annealing, normalizing and hardening) and effect of process on metallurgical structure and properties
16. Study of Jominy end - quench test for hardenability
17. Study of heat treatment defects, cause and remedies.
18. Industrial visits (at least one) for observing various heat treatment processes, furnaces, control systems and equt carrying out heat treatment of ferrous & nonferrous metals and alloys.

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2. THEORY OF MACHINES – II

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs):100 Marks
Term work: 25 Marks

Course Objectives :

1) To understand the basics of gear design and motion analysis and selection of gears and gear trains.
2) To demonstrate different types of gear trains and its applications.
3) To acquaint with working principles and applications of gyroscope and governors
4) To understand the procedure and effect of static and dynamic balancing of rotary and reciprocating masses.
5) To give awareness to students on the phenomenon of vibrations and its effects.

Course Outcomes:

The student shall be able to -

1) Develop designing skills and enhance thinking and analytical power of students to understand working of machines from design point of view.
2) Understand the need of gear, gear train, governors, gyroscope etc. from project point of view.
3) Understand the concept of basics of vibrations from application point of view.
4) Gain knowledge for solving problems in static and dynamic force analysis using graphical and analytical method.

Unit - 1

Gear: Introduction, law of gearing, involute and cycloidal profiles, gear terminology, length of path of contact, arc of contact, contact ratio, interference of involute gear teeth, helical and double helical gears.

(5)

Unit - 2
Gear Trains : Types of gear trains, analysis of gear trains. (4)

Unit -3
Balancing: Static and dynamic balancing, balancing of rotary masses, masses in the same plane, masses in different planes, balancing of reciprocating masses, primary and secondary balancing, balancing of locomotives, balancing of multi-cylinder inline engines, balancing of V-engines. (6)

Unit – 4
Gyroscope: Introduction, Gyroscopic couple, Effect of gyroscopic couple on motion of aero plane, naval ship, two and four wheelers, Gyroscopic stabilization (5)

Unit – 5
5.1 Governors: Functions of governor, types of governors, characteristics of governor, effort and power of governor. (5)
5.2 Flywheel: Crank effort, turning moment on crankshaft, turning moment diagram, fluctuations of energy and speed. (4)

Unit – 6
Vibrations:
6.1 Longitudinal and transverse vibrations: Introduction, types, natural frequency for various loading systems, Dunkerly's empirical formula, critical speed of shaft. (4)
6.2 Torsional vibrations: Introduction, natural frequency for single, two and three rotor system, bifilar, trifler suspension system, torsionally equivalent shafts, free torsional vibrations of a geared system.(5)

Term Work:
Minimum 8 experiments out of first 10 experiments from the following list.

1) Generation of involute gear tooth profile.
2) Study of differential gear box.
3) Experiment on verification of static and dynamic balancing principle.
4) Experimental verification of gyroscopic principle.
5) Determination of the governor characteristics of Porter and/or Hartnell governor.
6) Experiment on free longitudinal vibrations
7) Experiment on trifler suspension system.
8) Experiment on critical speed of the shaft.
9) Experiment on forced vibration
10) Measurement of vibrations by using vibration-measuring instrument.
11) At least one industrial visit to study applications related to the subject and submission of the relevant report. **(Compulsory)**

Text Books :

1) Theory of Machines and Mechanisms, by P. L. Ballaney, (Khanna Publishers, Delhi)
2) Theory of Machines, by S. S. Ratan, (TMH)
3) Theory of Mechanism and Machines by Ghosh and Mallik (EWP)
4) 04. Theory of machines, by Dr. R.K.Bansal, Laxmi Publication
5) Theory of Machines by R.S. Khurmi S.Chand and co.
6) Theory of Machines, by Thomas Bevan, (CBS Publishers, Delhi)

Reference Books:

1) Theory of Machines and Mechanisms, by John Uiker, Garden Pennock & Late. J. F. Shigley, (Mc Graw Hill Publications)

2) Theory of Machines, by W. Green,
3) Mechanical vibrations G.K. Grover
4) Mechanical Vibration Analysis- P.Srineevasan- Tata McGraw Hill
5) Theory and Practice of mechanical vibrations J.S.Rao K.Gupta – New Age International Publications.
6) "Machines and Mechanisms Applied Kinematic Analysis", David H. Myszka, Pearson Education, Asia.
7) "Design of Machinery", R. L. Norton, McGraw-Hill.
8) Theory of vibrations with applications- W.T.Thompson-Prentice Hall of India
9) Mechanical Vibrations- Schaum's outline series- McGraw Hill

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3. DESIGN OF MACHINE ELEMENTS

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs):100 Marks
Term work: 25 Marks

Course Objective:
To study the different types load considerations and design aspects of various machine members.

Course Outcome:
The students shall have the knowledge of the different types load considerations and design aspects of various machine members.

Unit-1
Introduction: Concept of machine design, general design considerations, design procedure; factor of safety for different types of loading its significance and selection ;theories of failures, Selection of engineering materials for a component considering functionality, raw material generating process, strength, cost, quantity and aesthetics, use of IS codes. (5)

Unit-2
a). Design for static loading: Knuckle joint, turnbuckle, cotter joint, levers. (3)

b). Design for fluctuating loads: Fatigue phenomena, concept of stress vs. number of cycles diagram and endurance limit, stress concentration and remedies, use of Goodman and Soderberg diagram in design of machine elements like shafts, springs and couplings. (5)

Unit-3.
Design of shafts, keys, splines and couplings: Design of solid and hollow shafts for strength and rigidity against pure torsion, pure bending, combined bending, torsion and axial loads; design of keys and splines; design of rigid and flexible couplings. (6)

Unit-4
a) Design of pressure vessels: Classification and design of thick a thin pressure vessels and cylinders. (2)

b) Design of joints: Design of bolted, riveted, and welded joints subjected under transverse and eccentric loading, materials for bolts, initial tightening loads on bolts, effect of washer and gasket, uniform strength bolts. (3)

Unit-5

a). Design of springs: Types, applications, spring materials, stress deflection equation of helical spring, Whal's stress factor, style of ends, design of springs for valves, clutches, buffers etc., design considerations for leaf spring. (4)

b). Design of power screw: Types, materials used, thread forms and their applications. types of stresses induced, overhauling and self-locking properties, re-circulating ball screw, design of nuts, methods of pitch error compensation for machine tools. (4)

Unit-6

a). Design of gears: a) Spur gears- materials, gear tooth loads, number of teeth, face width, strength of gear teeth, static beam strength (Lewis equation), dynamic tooth load, Wear strength (Buckingham's equation), estimation of module based on beam strength and wear strength, gear design for maximum power. (4)

b) Helical gears- No. of teeth, force analysis, beam and wear strength, effective load and design procedure (2)

c) Construction details of gears i.e. hub, web, arms, rim, gear Lubrication, gear tooth failures and remedies. (1)

Term Work:

Any Six of the following exercises.

(Note: Standard components shall be selected from relevant I.S. codes and Design Data Hand Books for the exercises given below.)

1) Study of Engineering Materials, their applications and selection as per different standards used in practice.
2) Design, stress analysis and working drawing of components and assembly of Cotter Joint, Knuckle Joint and Turnbuckle.
3) Design of Coupling and Detailed Working drawings with assembly.
4) Design of bolted, riveted and welded joints for transverse and eccentric loading.
5) Design of Gear Drive involving Gears, Shafts, and Keys with working drawings.
6) One assignment using CAD package on any one of the exercises 2, 3, or 5 above.
7) Two computer programs (or use of spreadsheet) on any of the above exercise.

Reference Books:

1) Design of Machine Elements, V. B. Bhandari, (Tata McGraw-Hill Publishing Company Ltd.)
2) Elements of Machine Design, N. C. Pandya and C. S. Shaha, (Charotar Publishing House)
3) Mechanical Engineering design, J. E. Shigley, Mitchell, (McGraw-Hill Publishing Co. Ltd)
4) Machine Tool Design, N. K. Mehta, (Tata McGraw-Hill Publishing Company Ltd.)
5) Design of Machine Elements, Dbrovalsky(MIR Publisher)
6) A Text Book of Machine Design, R. S. Khurmi, (S. Chand)
7) Design of Machine Elements by M. F. Spoots, T.E.Shoup (PHI)
8) Machine Design, R. K. Jain, (Khanna Publishers.)
9) Engg. Design, a Materials & Processing Approach, G. Dieter, (Tata McGraw-HillPublishing Company Ltd.)
10) Computer Aided Analysis and Design of Machine Elements by Dukki Patti, Rao,Bhat , (New Age, Delhi)

11) CMTI Machine Tool Design Handbook (TMH)
12) Design of Machine Elements, An Integrated Approach by Robert and Norton,(Pearson)
13) Machine Design by Black and Adams (McGraw-Hill Publishing Company Ltd)

Shivaji University, Kolhapur.
T. E. (Production Engineering) – Part I, Semester V

4. METROLOGY

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
Practical examination: 25 Marks

Course Learning Objectives: A Student should be -
1) Able explain the principles of measurement and its techniques.
2) Able demonstrate the design, construction and accuracy features of various instruments.
3) Able to acquire hands-on skills of measurement by using different instruments and gauges.

Course Outcomes: A Student should have-
1) Ability to describe measurement aspects.
2) Ability to design a measuring instrument.
3) Ability to maintain and service measuring instruments.
4) Develop the hands on skill in solving problems encountered during inspection.
5) Ability to use all types of measuring instruments.

Unit-1
Fundamental Principles of Metrology and Basic Measuring Instruments
Definition and scope of metrology, definition of measurement, primary, secondary, tertiary and working standards, line and end standards, advantages of optical standard precautions to minimize errors, measurement system and its characteristics, Vernier calipers, micrometers, height and depth gauges, - types, design considerations, specifications, applications, sources of errors and handling precautions, selection and general care of measuring instruments. Slip gauge box - Grades, materials, wringing, setting to sizes, precautions while use and storage Accessories - Bench centers, surface plates, V-blocks, angle plates. (8)

Unit-2
Comparators and Advance Measuring Instruments
Need for comparators, comparison of principles, mechanical, pneumatic, optical and electrical and electronic instruments, dial indicator, bore gauges and master rings, optical profile projector, tool makers microscope, electrical and electronic comparators, differential pneumatic comparator, and applications of pneumatic gauging. (5)

Unit-3
Gauges and Gauge Design
Concept of limit gauging, Taylor's principle, various types of plug, ring and snap gauges for plain and taper dimensions, gauge design for a given dimension for workshop, inspection and general grade gauges, fixtures and gauges for measurement ofpitch circle diameter, center distance between holes, positioning of holes and surfaces. (IS:919, Part 1, 1993-ISO system for limits, fits and tolerances, is to be used for gauge design) (4)

Unit-4

Measurement of Angles and Geometric Features

Bevel protractor, clinometer, sine bar, angle dekor, angle slip gauges, measurement of taper, angle and radius with the help of simple inspection set-ups using standard pins and balls Measurement of straightness, flatness, parallelism, squareness, circularity, roundness, concentricity, symmetry, distance between axes and other geometrical features Straightedge, level beam comparator, autocollimator. (5)

Unit-5

Gear, Thread and Surface Finish Measurement

a) Measurement of Screw Threads

Basic terminology, measurement of major, minor and effective diameter, Screw thread micrometer, floating carriage diameter measuring machine, two wire and three wire method, measurement of pitch and pitch error, thread pitch gauges, limit gauges for thread measurements

b) Measurement of gears

Basic terminology, measurement of pitch, lead, run out, back lash and tooth thickness, constant chord and base tangent method, Gear tooth Vernier caliper, David Brown tangent comparator, errors in gear geometry, measurement of composite error, Parkinson gear tester

c) Measurement of surface properties

Waviness and roughness, causes of variation in surface quality, different parameters for assessment of surface roughness, methods of calculation, instruments for surface roughness measurement. (10)

Unit-6

Advances in Industrial Metrology

Types, applications, Principle of digital measurement instruments and examples, Instrument-computer interface, Co-ordinate Measuring Machines (CMM), construction, working principle and applications, Objectives, Non Contact inspection methods, equipment; contact type inspection, Inspection robots. (4)

Term Work:

The term work shall consist of the following.

A) All the experiments listed below-

1. Measurement of linear dimensions using vernier, micrometer and bore gauge
2. Measurement of angle by using bevel protractor and sine bar
3. Dimensional measurement by using pneumatic comparator
4. Measurement of effective diameter of a screw thread by using floating carriage diameter measuring machine
5. Measurement of gear tooth thickness by using Chordal thickness and Base tangent method.
6. Measurement of roundness and concentricity by using dial indicator b) Measurement of radius by using inspection setup like rollers and pins
7. Measurement of roughness of machined surface
8. Assessment of profile of a component by using profile projector.

B) One assignment on Gauge design problem

C) One industrial visit to study inspection practices and submission of the report

Practical Examination: Each student shall perform individually, one assigned experiment from the above list and submit the result, followed by an oral examination.

Reference Books:

1. Engineering Metrology, -K. J. Hume, McDonald London

2. Engineering Metrology, -D. M. Anthony, Oxford University Press (I)
3. The Quality Technician's Handbook,- Garry Griffith, Prentice Hall
4. Engineering Metrology,- I. C. Gupta, DhanpatRai Publications
5. Principles of Machine Tool Design, -Sen, Gupta, New Central Book Agency
6. Basic Machine Technology, -C. Thomas Olivo, Bobbs-Merrill Educational Publishing
7. Machine Tool Practices,-Kibbe, Neely, Meyer, White, Prentice Hall
9. Engineering Metrology, -R. K. Jain, Khanna Publishers, Delhi
8. Testing of Machine Tools, -Dr. George Schlesinger, Pergamon Press
9. Basic Rules on using Measuring Tools, -Mitutoyo Metrology Institute
10. A Manual of Measurement System Analysis, Ford, General Motors, Chrysler Corporation
11. Metrology Laboratory Manual, -R. Bahl, M. Adithan, Technical Teacher's Training Institute, Chandigarh
12. A Text Book of Metrology, -M. Mahajan, DhanpatRai and Co.

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T. E. (Production Engineering) – Part I, Semester V

5. METAL FORMING & PLASTIC ENGINEERING

Teaching Scheme:
Lectures: 3 Hrs. / Week Theory
Practical: 1 Hrs. / Week/ Batch

Examination Scheme:
Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objectives:
1: Gain the fundamental knowledge about metal forming and plastic tech processes
2: Understand the analysis of flow of material and it's properties during the processes
3: Selection the process of metal forming as per the applications such as wire drawing, extrusion, rolling forging etc.
4:To introduce the students to the theory and practices of metal forming and plastics processing.

Course Outcome :
The students shall have the knowledge of fundamentals of metal forming and plastics technology

Unit-1
Theory of Plasticity
Flow curve, Concepts of true stress and true strain, plane stress condition ,stress tensor, yield criteria and their comparison., plastic stress-strain relationships. (6)

Unit-2
Introduction to Workability and rolling
Introduction to Workability
Overview at the workability, Strain tensor, strain hardening. Strain rate, Friction and Lubrication in metal forming (3)
Introduction to Rolling:
Classification of rolling processes, rolling mill types, deformation of metal in rolling, roll bite, elongation, reduction, defects in rolling, rolling of sheets, plates, bars, sections and tubes, applications (3)

Unit-3

Introduction to Extrusion and Drawing

Introduction to Extrusion

Equipment and principles, types of extrusion, direct, indirect, impact, hydrostatic, tube extrusion, metal flow in extrusion, defects, factors affecting extrusion load, (3)

Introduction to Drawing:

Types of Drawing, Rod/wire drawing, equipment and principles of process, defects, Tube drawing, Seamless pipe manufacturing. (3)

Unit-4

Introduction to Forging and Advanced Metal forming Processes

Introduction to Forging :

Basic operations, types of forging, forging hammers/ presses, forging stress and force calculations, die design considerations, forging defects, applications. (4)

Advanced Metal forming Processes:

Explosive forming, Electro-hydraulic forming, Electromagnetic forming, Magnetic pulse forming, hydro forming . (2)

Unit-5

Introduction to Plastic Materials and processes

Types, , thermosetting plastics, thermoplastics, laminated and reinforced plastics, applications.

a) Injection Molding: Process, equipment, applications.

b) Plastic extrusion: Process, equipment, extruders.

c) Calendaring- various calendaring processes, applications . (6)

Unit-6

Introduction to plastic molding and Thermoforming

a) Blow molding: Principles, material characteristics in blow molding, production of parison,

b) Rotational molding process for making hollow plastic articles.

c) Compression molding: Process, equipment, transfer molding.

d) Thermoforming- Process, heating equipment. (6)

Term Work:

The term work shall consist of the following.

1. Die design for a simple forged component including calculations and drawing
2. Designing layout for multi-pass wire drawing
3. Making simple components of suitable material using the following processes / equipment (Any two different components for a group of maximum four students each).
   a) Hot Forging
   b) Wire Drawing
   c) Extrusion
   d) Rolling
   e) Injection Molding
   f) Plastic Extrusion
4. Industrial visits (minimum two) for studying the metal forming and plastic processing and submission of reports

Reference Books:

1. Mechanical Metallurgy (S.I. Units) - Dieter, McGraw Hill
2. Manufacturing Processes – Begman, Amstead etc.(John Wiley)
3. Rowe, Principles of Industrial Metal working Processes,

4. ASM Handbook on Forming.
5. Forging and Forging Die Design - Sharan, Prasad, Saxena.
6. Rolling of Metals: Ivankove and Chaturvedi (Yantrik Publications, Mumbai)
7. Extrusion - Pearson (McGraw Hill)
8. Manufacturing Technology: Foundry, Forming and Welding by P.N. Rao (TMH)
9. Plastic Technology: Theory, Design & Manufacture – William J. Patton
10. Plastics-6/e, J. Harry DuBOIS, Frederick W. John, Van Nostrand Reinhold Co.
11. Manufacturing Engineering Technology by Kalpakjian (Addison Wesley)
12. Manufacturing Processes for Engineering Materials by Kalpakjian (Addison Wesley)
13. Injection Mold Design, R.G.W. Pye 4/e, Affiliated East West Press Pvt. Ltd. New Delhi.
17. Plasic Manufacture: Properties & Applications – N. J. Miss, ELBS
18. Plastics for Industrial Use- Sasse John

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6. METAL CUTTING THEORY

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 1 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objective:
To study the metal cutting technology including the process, measurements, design and selection of various cutting tools and their industrial specifications.

Course Outcome:
The students shall have the knowledge of fundamentals of metal cutting technology including the process, measurements, design and selection of various cutting tools and their industrial specifications.

Unit-1
Theory of Metal Cutting: Speed, Feed, Depth of Cut, Orthogonal Cutting and Oblique Cutting, Geometry of single point cutting tool, Mechanism of chip formation, Chip Breaker, Strain in Chip, Shear plane angle, Cutting ratio, Force relationship, Velocity relationship, Merchant circle, Ernst Merchant theory, dynamometer. (9)

Unit-2
Machinability: Concept of Machinability,

i) Cutting force: Effect of speed, feed, depth of cut, tool materials, angles and work material on cutting forces, specific cutting force, specific power consumption.
ii) Tool life: Flank and Crater wear, Mechanism of wear, effect of cutting parameter on tool life, Taylor's tool life equation.
iii) Surface Roughness: : Effect of speed, feed, depth of cut, tool materials, angles and work material on surface roughness, built up edge, chatter and its elimination. (9)

Unit-3
Sources of Heat Generation and Economics of Machining: Sources of heat generation, Types of cutting fluids, Selection of cutting fluids. Economics of machining; criteria for minimum cost and maximum production. (4)

Unit-4

Cutting Tool Materials: Single point tools - Definition of angles as per ASA system and ORS system, tool signature, Study of modern tool materials such as uncoated / coated carbides, Ceramics, cermets, cubic boron nitride, diamond etc., Desirable properties of tool material, Selection of tool grades and styles including specifications from commercial catalogues for different processes like turning, milling, drilling, grinding for different operations. (5)

Unit-5

Design of Form Tool: Design of flat form tool and circular form tool. Geometry, nomenclature, types, selection and applications of drills, reamers, milling cutters and broach. (5)

Unit-6

Design of single Point Cutting Tool: Design procedure of single point turning tool, High speed machining, Minimum Quantity Lubrication. (3)

Term Work:

1) Measurement of Cutting force with the help of Tool Dynamometer (Any Two)
    a. Lathe tool dynamometer
    b. Drill tool dynamometer
    c. Milling tool dynamometer
2) Machining of minimum two jobs of different materials such as C.I., Steel, Aluminium etc. and measurement of surface roughness to study the effect of parameters such as feed, tool nose radius, depth of cut on the surface roughness.
3) Design of form tool and broach for given components
4) Industrial visit to study applications of tools for different metal cutting processes.

Reference Books:

1) Cutting tools - P.H. Joshi - Tata McGraw Hill Publishing Co. Ltd..
2) Production Technology - HMT Handbook (TMH)
3) Metal Cutting Theory and Cutting Tool Design - Arshinov V. and Alekseev G., Mir Publication.
4) Metal cutting Theory and Practice- A. Bhattacharya, New Central Book Agency.
5) Metals Handbook, Vol. 16 Machining, A.S.M., Metals Park, Ohio.
6) Metal Cutting and Tool Design - Dr. Ranganath - Vikas Publishing House.
7) Metal Cutting Principals - Shaw M.C. - Oxford Calrendon Press, 1984.
8) Theory of Metal Forming and Metal cutting by Sinha, Prasad (DhanpatRai).
9) Machine Tool Engineering: K. R. Nagpal, Khanna Publication.
10) Tool Engineering handbook - ASTME, Frank Wilson (Editor) (TMH)
11) Text Book of Production Engineering (Tool Design) by K. Surendar and Umesh Chandra.
12) Commercial catalogues of tool manufacturers like SANDVIK, KENNAMETAL,TAEGUTECH, ISCAR, MITSUBISHI, Grindwell Norton, Carborundum Universal etc.
13) Fundamentals of Metal Cutting and Machine Tools B. L. Juneja, Nitin Seth.

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7. WORKSHOP PRACTICE – V

Teaching Scheme:
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Term work: 25Marks

Course Objectives:

1) Student should able to select the machine and do the planning of job operations.

2) Student should able to perform machining operations on various metal removing machines.

Contents & Term Work:

One composite job assembly consisting of at least 4 parts requiring the machining processes like turning, drilling, threading, tapping, milling, grinding etc. is to be completed under Workshop Practice – V (Two parts) and CAM lab and CNC Workshop Practice (Two parts) of T.E.(Prod) Sem-VI by each student.

Notes :

1. The composite job assembly is to be carried on to Semester VI under CAM lab and CNC Practice.
2. The term work of 25 marks based on Workshop Practice – V
3. The student shall maintain a diary of the work consisting of the process plan and work done in semester V – for Workshop Practice – V and in semester VI- for CAM lab and CNC Workshop Practice.

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T.E. (Production Engineering) – Part II, Semester VI

1. INDUSTRIAL MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs./Week	Theory Paper (3 Hrs.): 100 Marks
Practicals: 1 Hr./Week	Term Work: 25 Marks

Course Objective

To study the various functions of management essential for efficient & effective working of an industrial organization.

Course Outcome:

The students shall be able to demonstrate the knowledge of the functions of industrial management and an ability to identify, formulate and solve industrial management problems.

Unit-1

INTRODUCTION:

Management – meaning, definition, scope, importance, functions of management, development of management thought, contribution by Fayol, Taylor, Drucker, different approaches to management – scientific, operational, human and system approach, role and social responsibilities of a manager. (3)

PLANNING: Meaning, definition, scope, importance, objectives of planning, steps in planning, decision making, strategic planning, management by objectives (MBO) (3)

Unit-2

ORGANIZING: Meaning, definition, principles of organization, delegation of authorities and decentralization, span of management, types of organization – line, staff, project, functional and informal organizations (3)

STAFFING: Definition, functions of staffing, selection process, training and development, performance appraisal. (Numerical Problems on Man Power Planning) (4)

Unit-3

DIRECTING: Definition, principles of direction, importance motivation, theories of motivation – theory X and theory Y, Maslow's hierarchical needs, Herzberg theory, leadership – meaning, styles of leadership, types of leaders, trait theories, behavioral theories – managerial grid, Rensis Likert's leadership systems communication – importance, types of communication, barriers to effective communication, methods to overcome barriers (5)

CONTROLLING: Definition, steps in control process, requirements of effective control process, various control techniques (2)

Unit-4

FORMS OF ORGANIZATION: Proprietor, partnership firms, private limited, public limited, co-operative organizations, joint stock and public sector undertakings – structure of management, advantages and limitations, authorities and liabilities of owners (3)

HUMAN RESOURCE MANAGEMENT: evolution, objectives, functions, organization, introduction to industrial relations, trade unions and their functioning, significance of labor laws, human behavior at work, supervisor's role. (3)

Unit-5

FINANCE MANAGEMENT: Objectives, functions, kinds of capital, sources of capital, financial planning and control, profit planning, basic terms in financial accounting, reading and interpretation of balance sheet and profit and loss account. (Numerical Problems on Financial Planning & Accounting) (6)

PRODUCTION AND MATERIALS MANAGEMENT: Primary and secondary objectives, functions, organization, types and procedure of purchasing (3)

Unit-6

MARKETING MANAGEMENT: Objectives, functions, difference between marketing and selling, introduction to marketing mix, product planning, pricing policies, channels of distribution, advertising, market research. (Numerical Problems on Market segmentation, Pricing Strategies) (3)

INDUSTRIAL PSYCHOLOGY: Basic concepts of psychology, industrial psychology, scope, causation of behavior, individual differences, differences in psychological characteristics – intelligence, interest, physique, learning ability, perception, concept of psychological test (2)

Term Work:

Total Ten assignments based on the six units given above including at least four Numerical problems on Unit 2 & 6.

Reference Books:

1. Management by James A. F. Stoner, R. Edward Freeman, PHI
2. Management Today: Principles and Practice by Gene Burton and Manab Thakur, TMH
3. Essentials of Management by Koontz and O'Donell, TMH
4. Organizational Behavior by Keith Davis, TMH
5. Management (Tasks, responsibilities and Practices) by Peter Drucker, Harper Business
6. Production Management by Lockyer, ELBS
7. Modern Production Management by E. S. Buffa (John Wiley)
8. Financial Management by Vanhorne, PHI
9. Financial Management (Theory and Practice) by Prasanna Chandra, TMH
10. Marketing Management by Philip Kotler, Pearson Edition
11. Marketing Management by Rajan Saxena, TMH

12. Personnel Management by Edward Flippo, TMH
13. Managing Human Resources by Gorrez, Balkin, Candy, PHI

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T. E. (Production Engineering) – Part II, Semester VI

2. INDUSTRIAL HYDRAULICS AND PNEUMATICS

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
External Practical examination: 25 Marks

Course Objective:
To study of fundamental concepts, components, circuits and applications in industrial hydraulics and pneumatics.

Course Outcome:
The student shall demonstrate the knowledge of fundamental concepts, components, circuits and applications in industrial hydraulics and pneumatics.

Unit-1
Fundamental concepts of fluid & Introduction to fluid power : Classification of fluids, derivation of Pascal's law, continuity equation and Bernoulli's equation ,Introduction to fluid power: Types, advantages and applications, ISO symbols for hydraulic and pneumatic systems; hydraulic fluids- functions, desirable properties, grades and selection of fluid, conditioning of fluids, study of reservoirs, strainers, filters, heat exchangers. (7)

Unit-2
Hydraulic system elements: pumps – types, working, characteristics and applications, power and efficiency calculations (numerical treatment expected), types of conductors and connectors, their selection, seals and packing – types, materials, applications, hydraulic actuators – linear and rotary - types, working, cushioning effect, mounting, calculation of force and velocity of piston (numerical treatment expected), system components: accumulators, intensifiers, their types, working, applications, Control Elements: a)construction and working of pressure control valves – direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, b)Direction control valves – types, construction and working, spool actuation methods, spool center positions, c)Flow control valves – compensated and non compensated types, construction and working. (8)

Unit-3
Hydraulic circuits and their applications: Speed control circuits, regenerative, sequencing, counterbalancing, interlocking, synchronizing circuits, use of accumulator and intensifier, methodology to design hydraulic circuits. , maintenance of fluid power system , Electro -Hydro sytems: concept, working and applications (descriptive treatment only) (5)

Unit-4
Pneumatics: Basic principle, applications, comparison with hydraulic system, Pneumatic system elements: Piping, materials and pressure ratings, piping layout, calculation of pressure drop in pneumatic line; air compressors, types, selection criteria; FRL unit- construction and working; pneumatic cylinders

and air motors- construction, working and types, calculation of force and air consumption, comparison of air, hydraulic and electric motors. (6)

Unit-5

Pneumatic system control elements: Direction control valves- types and working, flow control valves, working of variable flow control, quick exhaust, time delay and shuttle valve. Fluidics: Concept, study of logic gates and applications. (6)

Unit-6

Pneumatic circuits: Basic circuit, impulse operation, speed control, sequencing, time delay circuits and their applications, pneumatic clamping systems, pneumatic power tools , maintenance of pneumatic system. (4)

Term Work :

1) Verification of Bernoulli's Theorem on Bernoulli's apparatus.
2) Study of pressure, direction and flow control valves in hydraulics and pneumatics using cut section models
3) Meter-in, Meter-out and Bleed-off, Sequencing, Counterbalancing, Synchronizing, Interlocking, pressure reducing circuits on hydraulic trainer.
4) Manual / automatic forward – reverse, sequencing, Basic logic circuits on pneumatic trainer.
5) Eletcro-Hydraulic systems- study and simple circuits.
6) Design of a hydraulic circuit for a given application and selection of components from commercial catalogs.
7) At least one industrial visit to study industrial applications of hydraulics and pneumatics with submission of the relevant report.

Note: Practical examination will consist of performing an actual experiment by a group of maximum two students, from the above list (Sr. Nos. 3 to 4) and to show working / results by the candidates, followed by oral examination on the term work.

Reference Books:

1) Fluid Power with Applications by A. Esposito (Pearson)
2) ABCs of hydraulic Circuits by H. L. Stewart and J. M. Storer (Taraporwala)
3) ABCs of Pneumatic Circuits by H. L. Stewart and J. M. Storer (Taraporwala)
4) Industrial Hydraulics by J. J. Pipenger, Hicks (McGraw Hill)
5) Hydraulics and Pneumatic Power for Production by H. L. Stewart (Industrial Press)
6) Fluid mechanics by R.K.Bansal, Laxmi publications. New Delhi.
7) Oil Hydraulic Systems by S. R. Majumdar (TMH)
8) Industrial Hydraulics Manual by Vickers Sperry
9) Pneumatic Systems-Principles and Maintenance by S. R. Majumdar (TMH)
10) Hydraulic Text Book Basic Level (Festo Controls Pvt. Ltd. Bangalore, (Part No. 93281)
11) Pneumatic Text Book Basic Level (Festo controls Pvt. Ltd. Bangalore) (Part No. 93131)
12) Pneumatics and Hydraulics by H. L. Stewart (Taraporwala)
13) Hydraulics and Pneumatics, A Technician's and Engineer's Guide by Andrew Parr (JAICO)
14) Fluid power engineering, M Galal Rabie, (McGrawHill)

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3. DESIGN OF JIGS, FIXTURES AND DIES

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Theory Paper (4 Hrs): 100 Marks
Term work: 25 Marks
External Oral Examination: 25 Marks

Course Objective:
To introduce the students to the design practices of tooling's (Jigs and Fixtures) and die design for presswork.

Course Outcomes:

1) The student shall be able to design drilling and reaming jigs for simple components
2) The students shall be able to design turning and milling fixtures for simple components
3) The student shall be able to design press tools and cutting/punching dies for simple components
4) The students shall be able to design drawing dies and blanks for simple component
5) The students shall be able to design different miscellaneous dies.

Unit-1
Introduction to Jigs and Fixtures : Necessity, applications and types, basic concept of jigs and fixtures for different manufacturing processes, dependency of jig and fixture design on operation sequence. (3)

Unit-2
Location and clamping system : Principles, types, applications, locating pins, pads, diamond pins, adjustable supports, Vee and post locators, clamping system -principle, types, screw clamp, strap, lever, hinge type, cam operated, toggle clamps, centralizer and equalizer clamp, multiple clamping, quick acting clamps, pneumatically operated clamps. (7)

Unit-3
Design of Jigs & fixtures :
A) Design of jigs: Principles of jig design, types of jigs- plate, template, box, channel, sandwich, latch, turn-over, tumble jig etc., types of bushes, selection of bushes and liners, construction of jig and fixture bodies, use of standard parts.
B) Design of fixtures: Principles of fixture design, types of fixtures- gang, straddle, vertical, slot, string milling fixture etc, selection of the suitable type, design of milling fixtures, use of setting block, tennons, T-bolts etc, design of turning fixture for lathe. Indexing System: Necessity, different indexing systems for jigs and fixtures. Concept of Modular Fixtures. (14)

Unit-4
Introduction to press tools: Dies, punches, types of presses, types of dies, simple, compound, combination and progressive dies, press tools for operations like blanking, piercing, drawing, shaving, trimming, etc. (4)

Unit-5
Design of die set for cutting operations: Theory of metal cutting, cutting force and blank holding force estimation, punch and die clearance, scrap strip layout, design of punches, design of dies, pilots, strippers, stock stops, finger stops, auto stops, center of pressure, selection of die set. (8)

Unit- 6

Design of drawing die: blank size determination, no. of draws, stage wise achievement of drawn component, stage wise component drawings, drawing radii and clearance, drawing forces, defects in drawing, Miscellaneous dies like- cut off dies, trimming, shaving, bulging, rubber, lancing, slitting, horn type, side cam dies, bending, forming, curling dies etc. (theoretical treatment only) (12)

Term Work:

1) At least one industrial visit to study industrial practices related to the subject and submission of the visit report.
2) Study of various elements of jigs and fixtures
3) Design and drawing of two drilling / reaming jigs. (Details of at least one sheet showing manufacturing drawing with tolerances, material specification and heat treatment.)
4) Design and drawing of two milling fixtures. (Details of at least one sheet showing manufacturing drawing with tolerances, material specification and heat treatment.)
5) Design and drawing of one progressive die.
6) Design and drawing of one drawing die.

Note: All standard components shall be selected using relevant IS codes in the following exercises.

Reference Books:

1) Tool Design, Donaldson, (TMH)
2) Tool Design, Pollock, Reston Pub. Co. Inc.
3) An Introduction to Jig & Tool Design, M.H.A. Kempster, (ELBS)
4) Fundamentals of Tool Design, Ed. Frank Wilson, ASTME (TMH)
5) Jigs and Fixture Design Manual, Henrikson (Industrial Press, NY)
6) A Text Book of Prod. Engineering, P. C. Sharma, S. Chand
7) Handbook of Die Design- Suchy, (McGraw Hill)
8) Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
9) Jigs and Fixture, P. H. Joshi, Tata Mc-Graw Hill Pub. Co
10) Techniques of Press Working of Metals by Eary and Reed
11) CMTI Machine Tool Design Handbook, (TMH)
12) Design Data Handbook –PSG College of Tech., Coimbtore

Shivaji University, Kolhapur.
T. E. (Production Engineering) – Part II, Semester VI

4. QUALITY MANAGEMENT

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objectives:

1) Student should able to demonstrate to the core concepts and the emerging trends in Quality Management.
2) Student should able develop hands-on-skills on tools and techniques of Quality management for industrial problem-solving.
3) To student should able to demonstrate implementation and documentation requirements for Quality system.

Course Outcomes: The student should have the-

1) Ability to describe quality.
2) Ability to design quality based manufacturing system.
3) Ability to document and implement quality systems.
4) Hands on skill in problem solving and controlling and improvement of quality.
5) Ability to use statistical tools and techniques

Unit -1

1. Introduction to quality management, historical background, contribution by quality gurus. (3)

Unit-2

2. Quality Planning: Designing for quality, capturing voice of customer, quality function deployment, quality loss function, signal to noise ratio, parameter design and optimization, tolerance design. (9)

Unit-3

3. Organizing for quality:, Quality systems: ISO9001 and TS 16949, Control of Non- conforming products, certification requirements, introduction to ISO 14000. (3)

Unit-4

4. Quality Control: Stages of inspection, Acceptance sampling plans, Product vs. Process control, Statistical quality control, Variable (Xbar –R) and Attribute (p, np, c and u) charts, Introduction to basic seven tools of quality control. (10)

Unit-5

5. Quality Improvement: Single parameter experiments, Orthogonal array, Analysis of Means, Analysis of Variance ANOVA (one - way), Statistical inferences, Variance reduction, Process capability, Correlation analysis, Linear regression models (9)

Unit-6

6. Introduction to Six Sigma methodology, D-M-A-I-C approach. Reliability, availability and maintainability (RAM) approach (3)

Term Work:

Any eight assignments using suitable statistical analysis software. on following topics.

1. Quality loss function
2. Parameter design and tolerance design
3. Quality function deployment
4. Variables control charts (X-bar &R charts)
5. Attributes control charts (P-chart)
6. Process capability study
7. Single parameter experiment and statistical inferences using one-way ANOVA
8. Correlation and regression analysis
9. Industrial case study on quality audit

Reference Books:

1. Armand V. Feigenbaum, Total Quality Control, McGraw Hill Inc. New York
2. J. M. Juran, F. M. Gryna, Quality Planning and Analysis, Tata McGraw Hill Publishing Co., New Delhi
3. E. Grant, R. Leavenworth, Statistical Quality Control, McGraw Hill International.
4. John Hardesky, Total Quality Management Handbook, McGraw Hill Inc.

5. D. H. Besterfield, Total Quality Management, Pearson Education
6. Logothetis, Managing for Total Quality, PHI Publication
7. Gregory Hutchins, Introduction to Quality, Maxwell McMillan International
8. Genichi Taguchi, Quality Engineering in Production Systems, McGraw Hill
9. John M. Ryan, Total Quality Control, Tata McGraw Hill Publishing Co.
10. P. F. Wilson, L.D. Dell & L.F. Anderson, Root Cause Analysis, A Tool for Total Quality Management, Tata McGraw Hill Publishing Co.
11. Montgomery D (2004). Introduction to Statistical Quality Control, 5/e, (John Wiley)
12. Ross, Phillip J. (1996) – Taguchi Techniques for Quality Engineering, 2/e. (New York, McGraw Hill)
13. Montgomery D (2001). Design and Analysis of Experiments, 5/e, (New York, John Wiley & Sons)
14. Montgomery D, Peck E, Geoffrey Vining G (2003). Introduction to Linear Regression Analysis, 3/e, (New York, John Wiley & Sons)
15. Phadke, M (1989). Quality Engineering using Robust Design, (Prentice Hall.)
16. Subburay Ramasamy, Total Quality Management (Mc Graw- Hill)
17. V.A.Kulkarni,A.K.Bewoor ,Quality Control(Wiley India)

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5. MACHINE TOOL DESIGN

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week/Batch

Examination Scheme:
Theory Paper(3 Hrs): 100 Marks
Term Work: 25 Marks

Course Objectives:
1. To understand core concepts of Machine Tool & Product Design.
2. To understand the basic approach for designing machine tool components and implement the appropriate method.
3. To compute the power requirements of various machine tools.
4. To learn to design quality based manufacturing system.
5. To learn to design a product using innovative concepts of 'Product Design'

Course Outcomes:
At the end of this course the student will be able to -
1. The student shall be able to apply the concepts of machine tool design.
2. The student shall be able to select the correct design approach & design the important components of machine tools.
3. The student shall be able to calculate the forces acting and the subsequent power requirements of machine tools.
4. The student shall be able to specifically design the critical components comprising a manufacturing system & emphasize on the quality of the system.
5. The student shall be able to analyse the various phases of the design cycle sequentially and envision the concept of "Scratch to Market" w. r. t a product.

Unit-1

Introduction to Machine & Machine Tool

Types, capabilities, features of construction like working & auxiliary motions in machine tools, parameters defining the working motions of a machine tool, machine tool drives, general requirements of machine tool design, methodology for machine tools design considering quality, quantity of production and economic aspects.

Principle of Machine Tool Design from the point of view of quality, production rate, strength, rigidity, assembly, ergonomics, aesthetics, maintenance and interchangeability

(6)

Unit-2

a) Analysis of forces

Forces affecting machine tool elements, determination of motive power for different operating conditions, use of handbooks. (2)

b) Design considerations and selection of standard components

Drive systems with pulleys, belts, ropes and chains; selection of oil seals, gaskets and electric motors from standard catalogues. (3)

Unit-3

Kinematics of Machine Tools

Classification of various driving systems, basic considerations in the design of drives, aims of speed & feed regulation, stepped regulation of speeds, design of gear box, laws of stepped regulations, selection of range ratio, G.P. ratio, break up of speed steps, structural diagram, Ray diagram & speed chart, design of feed box, machine tool drives using multiple speed motors, general recommendations for developing gearing diagram, determining the number of teeth on gears, stepless regulation of speed and feed rates.(8)

Unit-4

a) Design of Spindle & Spindle Support

Functions of spindle unit and requirements, materials and construction, spindle ends, spindle support, design calculations, mounting arrangements of spindle bearings, spindle bearing lubrication (3)

b) Selection of Machine Tool Bearing

Journal, rolling and hydrostatic bearings, basic principles, assembly, mounting and maintenance, procedure for selection of bearings from manufacturer's catalogue based on load and life considerations

(4)

Unit-5

a) Design of Machine Tool Structures

Functions of machine tool structures and their requirements, design criteria, materials, static and dynamic stiffness, profiles of machine tool structures, basic design procedure, design of beds, columns, housings, rams etc, Causes of vibrations in machine tools and methods of elimination. (4)

b) Design of Guide ways

Functions and types of guideways, materials, design criteria and calculations of slide-ways based on wear and accuracy, design of anti-friction guideways, hydrostatic and hydrodynamic lubrication of guideways.

(4)

Unit-6

a) Product Design and Development

Product design by evolution and innovation, essential factors of product design, analysis of the product, product characteristics, 3 S's – simplification, standardization and specialization, basic design considerations, functional design practice, product value, design for safety, reliability and environmental conditions, ergonomic design of controls and displays, introduction to rapid prototyping. (3)

b) Intellectual Property Rights (IPR)

Trademarks, copyrights, patents and its procedures. (2)

Term Work:

1) Design of a gear box for speed and feed drive, design of shafts and gears with assembly drawing.
2) Selection of bearings from manufacturer's catalogue
3) Study of different machine tools from the point of view of types of machine parts.
4) Exercise on design of machine tools from ergonomic aspects suitable in India.
5) One case study on product design and development. (Report to be submitted)
6) Assignment on IPR with case study.

Text Books

1) Basic and Applied Thermodynamics by P.K.Nag (TMH).
2) Thermal Engineering by R.K. Rajput (Laxmi Publications).
3) Thermal Engineering by P.L. Ballaney (Khanna Publishers).
4) Thermal Engineering by B.K. Sarkar (TMH).
5) Thermal Engineering by Kodandaraman (New Age International Publication).

Reference Books

1) Machine tool design by N.K.Mehta (TMH).
2) Principles of machine tools by Gopal Chandra Sen and Amitabh Bhattacharya (New Central Book Agency).
3) Machine Tool Design Handbook, C.M.T.I, Bangalore, (TMH).
4) Design Data Handbook, PSG College of Tech., Coimbatore.
5) Design of Machine Tool, Dr. S. K. Basu (Oxford IBH)
6) Design of Machine Elements, Dobrovalsky.
7) Design of Machine Elements, V. B. Bhandari, Tata McGraw-Hill Publishing Company Ltd.
8) Elements of Machine Design, N. C. Pandya and C. S. Shaha, Charotkar Publishing House
9) Design Data Handbook, K. Mahadevan and Balveera Reddy, C.B.S Publishers & Distributors.
10) Engineering Design, a Materials and Processing Approach, G. Dieter, Tata McGraw-Hill Publishing Company Ltd.
11) Product Design and Manufacturing, (3/e), A. K. Chitale and R. C.Gupta, Prentice Hall of India Pvt. Ltd.
12) Catalogues of Bearing Manufacturers, example, S.K.F, NACHI, TIMKEN, NRB etc.

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6. CAM LABORATORY AND CNC WORKSHOP PRACTICE

Teaching Scheme:
Practical: 4Hrs/batch/week

Examination Scheme:
Term Work: 50 Marks
Practical Examination: 50 Marks

Course Objective:
To study advanced features of Computer Aided Manufacturing practices followed in the industry.

Course Outcome:
The student shall demonstrate the knowledge of advanced features of Computer Aided Manufacturing practices followed in the industry.

Contents & Term Work:

1) Selection of cutting parameters including tool specifications for various operations on CNC machines–Turning Center and Machining Center. (2)

2) Study of the features of the controller of the CNC machines (e.g. FANUC, SINUMERIC, MAZAK etc.) including Tool offsets, Wear Compensation etc. (2)

3) CNC Part Programming - Detailed Manual part programming on Turning Center and machining centers using G & M codes for various operations on CNC machines–

    a) CNC Part Programming for Turning Center: Stock Removal Cycles: Facing and turning, Finishing Cycles, Drilling cycles.

    b) CNC Part Programming for Machining Center: Canned Cycles, Pattern Repeat cycles, Sub programming and sub routines, Rotation of Coordinate System, Polar coordinate system. (8)

4) Generating and simulating CNC part programs from the CAD models (at least two exercises each). Preparing a suitable CAD model for a part to be turned and generating the CNC part program to machine the same on a CNC Turning Center from the given form of raw material using suitable CAM software and a post processor. Simulation of the above programs using any suitable CNC simulation software. (8)

5) Preparing a suitable CAD model for a part to be machined and generating the CNC part program to machine the same on a CNC machining center (vertical/horizontal) from the given form of raw material using suitable CAM software and a post processor. (2 dimensional machining like turning, facing, threading, drilling, face/slot milling etc, and rectangular, circular pockets, cavities.) (10)

6) Generating a simple part program using CAM software and executing it on a CNC machine (at least one exercise each) on CNC lathe and CNC machining center. (10)

IMPORTANT NOTES:

1) During CNC practice each student has to perform the machining of at least two parts of the assembly undertaken during the Workshop Practice-V of B.E. (Prod) Sem-5 on CNC Turning Center or CNC machining center.

2) Each student shall perform the CNC programming for a separate component as referred in point 6 above.

3) The external practical examination shall include execution of one assigned job & its operation on CNC Turning Center or CNC machining center followed by an oral examination.

4) The print outs of CAM & CNC programs and relevant reports of the above mentioned laboratory work shall be included in the journal.

Reference Books:

1) Jon Stenerson and Kelly Curran "Computer Numerical Control", Prentice-Hall India Pvt. Ltd. New Delhi, 2008
2) Ibrahim Zeid "CAD/CAM – Theory and Practice" Mc Hill, International edition, 1998
3) P. N. Rao "CAD/Cam principles and operations", Tata McGraw Hill
4) Thomas M. Crandell "CNC Machining and Programming, Industrial Press ISBN-0-831-3118-7
5) Bedworth, Wolfe and Henderson-Computer aided design and manufacturing, McGraw Hill.
6) A. Ghosh and Malik – "Manufacturing Science" Affiliated East West Press Pvt. Ltd.

7) Tilak Raj – "CNC Technology and Programming", Dhanpat Rai Publication Company.
8) Robert Quesada, T. Jeyapoovan "Computer Numerical Control: Machining and Turning Centers", Pearson Education.
9) Programming Manuals of various CNC machines (Lathes and Machining Centers) e.g. FANUC, SINUMERIC, MAZAK etc.
10) Catalogs of Commercial Tool Manufacturers e.g. SANDVIK, KENNAMETAL, ISCAR, TAEGUTECH, MITSUBISHI etc.
11) Manuals of CNC Simulation and CAM Software.
12) Reference Manuals of controllers like FANUC, Siemens, Mazak, etc.

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T.E.(Production Engineering) – Part II, Semester-VI

7. RESEARCH SEMINAR

Teaching Scheme:	**Examination Scheme:**
Practical: 1 Hr. / Week	Term work: 25 Marks

Course Objective:
To train the students to the techniques of conducting a minor research based on the literature review and compiling systematic report and presenting it before a group of peers and faculty.

Course Outcome:
The students shall demonstrate the knowledge of techniques of conducting a minor research based on the literature review and compiling systematic report and presenting it before a group of peers and faculty.

Contents & Term Work:
Before the end of Semester VI, each student will deliver a research seminar on a subject related to production engineering. The research seminar topic shall be latest and ahead of the scope of curriculum. The research seminar guide shall help the student in topic selection.

The student, as a part of the term work, shall systematically prepare and submit the report of the research seminar work in duplicate, typed on A4 size sheet in a prescribed format and bound. The report shall be compiled and edited very meticulously right from research problem definition to final conclusions & references. Mere copying and pasting must be avoided.

The student shall present the research seminar before the group of peers & faculty. The performance of the student shall be judged by the research seminar guide along with one more colleague on the basis of the contents, literature review, research problem definition, research objectives, research methodology, results & conclusions, the presentation and discussions.

√ IMPORTANT INSTRUCTIONS FOR INDUSTRIAL TRAINING & PROJECT WORK:

1) Each student should undergo an industrial training in a manufacturing industry during the vacation period for at least 15 days after the end of T.E.(Prod) Sem.VI examinations and prepare a training report in the prescribed format under the guidance of the guide allotted during B.E.(Prod) Sem. VII.
2) For the details, refer the syllabus of B.E.(Production) Sem. VII.
3) The department should guide and orient the students for the said industrial training as well as the selection of suitable problem for the Project Work (B.E.-Prod. Sem. VII & VIII) during T.E.(Prod) Sem.-VI.

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B. E. (Production Engineering) – Part-I, Semester VII

1. OPERATIONS RESEARCH

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs./ Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr./ Week/ Batch	Term work: 25 Marks

Course Objective:
To study the quantitative techniques in management decision-making and its applications by using mathematical models.

Course Outcome:
The students shall demonstrate the knowledge

Unit1-1

Introduction to O.R and Linear Programming:
Birth of O.R., Methodology, Scope and Limitations. Types of O.R. Models, Applications in Production Management, Use of computers in O.R, Linear Programming: Formulation, graphical method. (5)

Unit-2

Linear Programming Problems
Simplex algorithm for maximization and minimization problems, sensitivity analysis, duality theory and its use in economic interpretation and decision making. (6)

Unit-3

Transportation and Assignment Models:
Structure, Industrial and business applications

a) **Transportation problems**: Use of various methods for solving transportation problems, degeneracy and its solution.
b) **Assignment problems**: Solution of various types of problems, Traveling Salesman problem. (7)

Unit-4

Sequencing and Replacement Analysis

a) **Sequencing**: Sequencing of n jobs and 2 and 3 machines, 2 jobs and m machines.
b) **Replacement Analysis**: With and without time value of money, single item and group replacement. (6)

Unit-5

Project Management

Fundamentals of CPM / PERT networks: CPM – construction of networks, critical path, forward and backward pass, floats & their significance, crashing for minimum cost and optimum and minimum duration, resource allocation and leveling.
PERT – Time Estimates, Construction of Networks, Probability of completing projects by given date. (8)

Unit-6

Decision Theory and Network Techniques:

a) **Decision Theory:** pay off and regret tables, decision rules, decisions under uncertainty and risk, decision tree.

b) **Network Techniques:** Shortest path model- Dijkstra's Algorithm, Floyd's Algorithm. (6)

Note: The University question paper shall include numerical treatment on all units.

Term Work:

It shall comprise of the following numerical assignments .At least two assignments must be based on Case study. Use of computers is essential for at least two assignments

1. Formulation of LPP and Graphical Solution.
2. Assignment on Maximization / Minimization of L. P. Problems.
3. Assignment on Transportation / Assignment Problems.
4. Assignment on Replacement Analysis.
5. Assignment on Sequencing Problems.
6. Assignment on CPM/PERT Problems
7. Assignment on Decision Theory.
8. Assignment on Shortest Path Models

Reference Books:

1) Introduction to O.R., 7/e (with CD) – Hamdy A. Taha, (PHI)
2) Quantitative Techniques in Management, 4/e - N.D. Vora. (TMH)
3) Introduction to O.R., 7/e (with CD) – Hillier & Lieberman (TMH)
4) Operations Research, 2/e – R. Panneerselvam (PHI)
5) Operations Research- Natarajan, A.M.; Balasubramani, P. & Tamilrasi A. (Pearson Education)
6) Operations Research – J.K. Sharma. (Mac Millan)
7) Operations Research – P. Sankara Iyer (TMH- Sigma Series, 2008)
8) Operations Research – Principles & Practice - Ravindran, Phillips & Solberg (John Wily & Sons, Wiley India, 2006)
9) Introduction to Operations Research-Theory & Applications, - H.S. Kasana & K.D. Kumar, (Springer International Edition, 2005, Springer India)
10) Operations Research- Applications & Algorithms, 4/e, - Wayne L. Winston (CENGAGE Learning 2003)

Shivaji University, Kolhapur.
B. E. (Production Engineering) Part-I, Semester VII

2. MECHATRONIC SYSTEMS

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
Practical Examination: 25 Marks

Course Objective:

To understand working principle of necessary components required for Mechatronic Systems and their applications in system designing.

Course Objective:
The student shall demonstrate the knowledge of the working principles of necessary components required for Mechatronic Systems and their applications in system designing.

1) Control Systems: Components of Mechatronic systems, Types of Control Systems, concept of transfer function, Modes of control on/off, P, PI, PD and PID, Adaptive control system, System modeling of mechanical, electrical, fluid systems, D.C. motor and generator; Types of standard inputs (signals), Time response specifications of first and second order systems (6)

2) Sensors, Transducers and Actuators: Performance, terminology, characteristics, types, binary and analog; Contact and non-contact type switches and proximity sensors- inductive, capacitive, optical, pneumatic, potentiometric, thermal, incremental and absolute encoders, tachogenerator; Applications in position, displacement, velocity, force, torque and temperature measurement; **Actuators** – working principle and applications: Variable frequency AC drives, Pulse width modulation and cycloconvertor for controlling AC frequency, Brushless DC servomotors, timing motors, torque motors, SCR (Silicon Controlled Rectifiers) motors, Stepper motors- types, specifications and control, relays and solenoids. (10)

3) Programmable Logic Controllers (PLC) and Supervisory Control And Data Acquisition (SCADA): Structure, input/output units and input/output processing, programming, ladder diagrams, logic functions, latching, sequencing, timers, counters, jumps, analog input/output and applications, Concept of SCADA, its industrial significance and applications. (6)

4) Microcontroller: Architecture and pin diagram of 8051 controller, Programming of microcontroller, selection of microcontroller for automation applications, interfacing. (4)

5) Signal Conditioning and Interfacing: Signal conditioning processes, clock signal, voltage divider, rectification, Operational Amplifiers: inverting and non-inverting, summing, integrating, differential, logarithmic, comparator; 555 timer, sample and hold, analog to digital and digital to analog converters, multiplexing and de-multiplexing, Interfacing input output ports, serial and parallel interfacing requirements, buffers, handshaking, polling and interrupts. (6)

6) MEMS: Overview of MEMS and Microsystems, typical MEMS and Micro system products and applications. (i) Micro sensors and micro actuators: phototransistors, pressure sensors, thermal sensors, micro grippers, micro motors, micro valves, micro pumps (ii) Micro-manufacturing: bulk manufacturing, surface manufacturing, LIGA process. Case study of Mechatronic systems in manufacturing and automation. (6)

Term Work:
1. Fabrication of a simple mechatronics working project by a group of 2-3 students, (A list of some sample projects is given further. One Project shall be carried out by each of the student groups and submitted as a part of term work.).**
2. Minimum two programs and their execution on PLC for logic, timer, counter and sequencing applications involving use of sensors for position, displacement and velocity.
3. Use OPAMP KITS to perform experiments (minimum two)
4. Interfacing of stepper motor with microcontroller/PLC for position, speed and direction control
5. One Exercise involving programming of microcontroller with interfacing of sensors for simple control applications like temperature control, pressure control, position control etc.
6. Simple MATLAB/SCILAB Programming exercises for control system (minimum two).
7.One assignments on SCADA applications for simple problems.
8. Industrial visit to study Mechatronic system application and submission of visit report.

****Note:** This project exercises shall include use of PLC, microcontroller, various sensors, Analog-to-digital and Digital-to-analog conversion, simple electronic circuits etc. for Mechanical/Production Engg. applications.

The list given below is indicative only and other suitable projects may be undertaken.
List of Sample Projects: Automatic door control (Open/Close), Water level control, Automatic Belt conveyor, Soft touch bi-directional motor control, Temperature sensor with analogue to digital output, Overheat control using heat sensor to operate cooling fan, Automatic railway gate control, Clap operated relays, Piece counters etc.

Note for Practical Examination: A batch of not more than two students shall perform any one exercise from 2, 3, 4 and 5 of above-mentioned list and show the results. This will be followed by oral examination.

Reference Books:

1. Ogata – Modern Control Engineering (Pearson Education) ISBN 81-7808-579-8
2. Industrial Automation – David. W. Pessen (John Wiley & Sons) ISBN 9971- 51-054-5.
3. Automated Manufacturing Systems: Sensors, Actuators – S. Brain Morriss (McGraw Hill) ISBN 0-07-113999-0
4. Mechatronics 3/e - W. Bolton (Addison Wesley) ISBN 81-7758-284-4
5. Introduction to Mechatronics & Measurement System – David G. Alciatore & Michael B. Histand (TMH) ISBN 0-07-052908.
6. Mechatronics Principles, Concepts & Applications – N.P.Mahalik (TMH) ISBN 0-07- 0483744
7. Mechatronics – Dan Necsulescu (Pearson Education) ISBN 81-7808 -676 – X.
8. The 8051 Microcontroller: Architecture, Programming & Applications, 2/e – Kenneth J. Ayala (Penram International) ISBN – 81-900828-7
9. Computer Control of Manufacturing systems-Yoram Koren (McGraw Hill) ISBN 0-07-066379-3
10. MEMS & Microsystems Design & Manufacture – Tai – Ran Hsu – TMH 0-07-048709.
11. MEMS – Mahalik, N.P. (TMH) ISBN :13 978-0-07-063445-9
12. CAD/CAM –Concepts & Applications, Channakesava R. Alavala (PHI)
13. Mechatronics, Singh, M.D,. & Joshi J.G. (EEE) (PHI) (2006- ISBN 81-203-2986-4.
14. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

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3. PRODUCTION AND OPERATIONS MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective:
To study the concepts of Production and Operations Management and their applications.

Course Outcome:
The students shall demonstrate the knowledge of the concepts of Production and Operations Management and their applications.

Unit -1

1. Introduction: definition, importance, relative position in organization, functions of production management, types of production and their characteristics, continuous and intermittent.

a) Pre-production functions:

i) Product design and development: marketing, functional, manufacturing and economical aspects, 3 'S' - simplification, standardization, specialization.

ii) Sales forecasting: use of forecast, types, accuracy, statistical forecasting, types of demands, various types of forecasting methods, verifying and controlling the forecast.

iii) Capacity and Aggregate Planning: Definition, Measure of Capacity, capacity strategies Estimation of number of machines, Overcapacity and under capacity factors,

Aggregate Planning- Strategies, Pure and mixed strategies, Use of transportation model approach to aggregate planning, requirement of personnel, make or buy decision, line balancing, (8)

Unit - 2

a) Production Planning:

Production functions- routing, scheduling, machine loading, intermittent and continuous routing -Process charts, job cards, route cards, operation charts, Scheduling: definition, need and objectives, factors affecting, Loading: machine loading, techniques. Drum-buffer-rope concept: Production scheduling application in Theory of Constraints

b) Production Control: Definition, dispatching, progressing, coordination, Dispatching: job orders and issue systems, dispatching rules. Progressing: follow up, feedback, corrective actions. Coordination: relationship of PPC department with other departments, coordinating with other departments for planning and execution. (5)

Unit - 3

a) Introduction to Modern Production/Operation Management Techniques: Toyota Production System, Five 'S', Lean manufacturing, Poka Yoke, Kaizen, SMED, Introduction to Six Sigma concept and methodology. (6)

Unit - 4

Inventory Management:

a) Aims, buffer stocks, lead time, ROL, fixed order quantity system, periodic review system, Selective Inventory Control Techniques - ABC and VED analysis, JIT manufacturing /purchasing,

b) Inventory Models: Various costs involved, classification of models, EOQ model with and without shortage, EOQ with uniform demand and production lot size model, EOQ model with single price break.

c) Stores Management: objectives, functions, procedure, documentation, stock taking and reconciliation (8)

Unit - 5

a) Supply Chain Management: Definition, decision phases in supply chain, process view of supply chain, importance.

b) Logistics Management: Meaning, scope and elements of logistics, need for logistics Engineering (5)

Unit - 6

a) Maintenance: Types, break down, preventive and predictive (condition based maintenance), selection of maintenance strategy, Total Productive Maintenance –Concept, Calculations of OEE.

b) Safety and Disaster Management: Reasons, analysis and prevention in manufacturing establishments.

c) Human Consideration in Production Management: Industrial Psychology – Introduction, motivational factors, behavioral aspects, grievances, working conditions, safety; shop supervisor's role in above functions. (6)

Note: The University question paper shall include numerical treatment on all six units.

Term Work:
It shall comprise of the following assignments. The assignments shall be different for each group of about 3-4 students each. At least two assignments must be based on Case study. Use of computers is essential for at least two assignments.

1) A Case study on Pre – production functions
2) Exercise on Production planning/scheduling of batch production of about 5 – 10 variety of parts for given batch sizes with preparation of Gantt's Chart
3) A case study on production control and production status reporting
4) A case study on rejection analysis on shop floor
5) Exercise on formulation of maintenance strategy in manufacturing industry
6) A case study on Supply Chain Management in manufacturing industry
7) A case study on logistic management in manufacturing industry
8) Industrial visit to study various Production/Operations management techniques and preparation of report

Reference Books:

1) Production Planning & Control – Samuel.Eilon (Universal)
2) Production Systems – James L. Riggs (Wiley)
3) Production Management – Lockyer (ELBS)
4) Production Handbook – Carson, Boltz & Young (Ronald Press)
5) Production Management – R. Mayer (McGraw Hill)
6) Operations Management: Strategy & Analysis, 6/e – Krajewsky, Ritzman (Pearson Education)
7) Modern Production Management – E.S. Buffa (John Wiley)
8) Production Management – Burbridge (ELBS)
9) Operation Management – Schroeder (McGraw Hill)
10) Stores Management – K.S. Menon (Mac Millan)
11) Just In Time Manufacturing – Korgaonkar (Mac Millan)
12) Supply Chain Management; Strategy, Planning & Operation – Sunil Chopra, Peter Meindl (Pearson Education Asia)
13) Logistics Engineering & Management – Bejamin S. Blanchard (Pearson Education Asia)
14) Total Quality Management - R S Naagarazan, A A Arivalagar. Publisher-New Age International
15) Stein, R. E., (1996) Re-engineering the manufacturing system: applying the theory of constraints (TOC). Marcel Dekker.
16) Operations Management – B. Mahadevan, (Pearson Education)
17) Operations Management- Haizer & Render, (Pearson Education)

Shivaji University, Kolhapur.
B. E. (Production Engineering) – Part-I, Semester VII

4. PROCESS ENGINEERING

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (4 Hrs): 100 Marks
Term work: 25 Marks
Oral Exam: 25 Marks.

Course Objective:
To understand the fundamentals of process engineering in a manufacturing industry.

Course Outcome:
The students shall demonstrate the knowledge of the fundamentals of process engineering in a manufacturing industry.

Unit-1
Introduction: Process planning function and activities-drawing interpretation, material evaluation and process selection, selection of machines and tooling, setting process parameters, work-holding devices, selecting quality assurance methods, costing and documentation, Inputs and outputs for process planning, Position of product and process engineering department in the organisation, functions of product and process engineers. (7)

Unit-2
2.1 Part Print Interpretation: Indentifying Originating process, major and minor operations, identifying useful supplementary information, material specification and treatments, interchangeability and standardization, screw thread forms, tool references, dimensional and geometrical tolerances, surface finish, identifying critical processing factors (5)

2.2 Study of Machining Accuracies: Factors affecting accuracies, work piece control theories, product tolerances, process tolerances, tolerance stack -types and effects. (6)

Unit-3
3.1 Technical Feasibility Study: Raw material, basic originating process, accuracy level, processes required, machine tools and accessories required Manufacturing feasibility study with illustrations (3)

3.2 Selection of Process: General guidelines for and factors in process selection, process selection method, process and operation sequencing – guidelines; Combining and eliminating operations, economic aspects of processing (A case should be discussed), Introduction to computer aided process planning-Generative and Retrival type. (7)

Unit-4
4.1 Selection of Equipment: Various sources of information, technical, economical and managerial considerations, selection criteria for GPMs, SPMs and CNCs for processing in job, batch and mass mode. (3)

4.2 Selection of Tooling: Technical specifications of standard cutting tools and gauges required for various machining operations, selection criteria for cutting tools and gauges, study of special tools, gauges and work holding devices, selection of machining parameters. (5)

Unit-5
5. Process Planning: Preparation of process sheet for machining of a component for job, batch and mass production using conventional and CNC machines, Selection of quality assurance method and tools, in-process gauging. Process Picture sheet including process symbols. Process sheet design. (8)

Unit-6
Time Estimation: Calculation of standard time and production rates for various operations by consideration of various allowances.(Numerical exercises expected) Takt-time concept. (4)

Term Work:
1) Part print interpretation of one industrial component drawing
2) Study of formats of Process sheets, Process pictures and PPAP documents.
3) Process design of one component (made from casting, forging, bar stock, etc.) on conventional and

CNC machine tools for batch production

4) Process design of one component for mass production using SPMs considering combination of operations for achieving targeted cycle time on each SPM.
5) Time estimation for processing a component on conventional and CNC machine tools for batch production (one exercise each)
6) Industrial visit to study process designing and its report. During process design, use of cutting tool manufacturers' catalogues is essential.

Note for paper setters:
The pattern of question paper shall be as given bellow:
Q.1 Process Planning for a given component drawing (35 Marks) Compulsory question.
Q.2. Theoretical / Descriptive questions based on Syllabus with internal options (15 Marks)
Q.3 Process Planning for a given component on CNC Lathe or Machining Centre (VMC/HMC) (18 Marks) Compulsory question.
Q4. Numerical exercise on time estimation of one operation setup (12 Marks) Compulsory question.
Q.5 and 6 Theoretical / Descriptive questions based on Syllabus with internal options (15 Marks)

Reference Books:

1) Process Engineering for Manufacturing – Eary & Johnson (Prentice Hall)
2) Process Planning: The Design/Manufacturing Interface, –Petert Scallan, (2003), (Buttreworth Heinmann, Elsevier) ISBN: 0-7506-51-29-6
3) A Text Book of Production Engg, –P.C. Sharma, (Millennium Edition, 2000) S. Chand & Co.
4) Principles of Machine Tools- Sen, Bhattacharya
5) Automation, Production Systems, and C.I.M. – Groover, M.P. 3/e, (PHI)
6) Workshop Technology Vol. III – Chapman (ELBS)
7) Manufacturing Technology: Principles for Optimisation – Daniel
8) Mechanical Estimating and Costing – TTTI Chennai (TMH)
9) Standard manuals of ISO, QS, TS etc.
10) Manufacturers' catalogues for cutting tools and inspection equipments
11) Product Design-Kevin Otto and Kristin Wood (Pearson)
12) All About Machine Tools-Heinrich Gerling (New Age International)
13) Westerman Tables (Metals) (New Age International)

Shivaji University, Kolhapur.
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ELECTIVE – I: 1. AUTOMOBILE ENGINEERING

Teaching scheme:	**Examination scheme:**
Lectures: 3 Hrs/week	Theory Paper (3 Hrs.): 100 Marks
Practicals: 2 Hrs/ week	Term work: 25 Marks

Course Objective:
To study the fundamentals, types, construction and working principles of automobiles and its parts & systems.

Course Outcome:
The students shall have the knowledge of the fundamentals, types, construction and working principles of automobiles and its parts & systems.

Unit-1:

Introduction to Automobiles:

Classification of Automobiles, Major Components and their functions, Vehicle Specifications, Types of vehicle drive layouts for four wheelers, Drive layouts for two and three wheelers, Types of automobile bodies, Body construction and different materials for modern automobiles, Articulated vehicles, Selection of engines for different automobiles based on different criteria. Fuel cells, Electric vehicles, Hybrid Vehicles, Advantages and Limitations.

Fuel Supply Systems for SI Engines: Carburetion, air fuel requirements for SI engines under various operating conditions, essential parts of a modern carburetor, different circuits, carburetors used on automobiles, fuel injection in SI engines.

Fuel Supply Systems for CI Engines: Functional requirements of an injection system, typical arrangement of solid injection system, individual pump and; nozzle system, unit injectors, distributor system, fuel injectors, types of nozzles.

Ignition Systems: Battery ignition system, magneto ignition system, electronic ignition systems, waste spark ignition system. Different starting systems used in automobiles. (10)

Unit-2:

Study of Clutches and Gear Boxes:

a) Clutches: Types of clutches, single plate, multiplate, centrifugal clutches, clutch operating systems, wet clutches, fluid coupling, clutch plate materials. (3)

b) Gear Boxes: Functions of gear box, various resistances to motion, rolling, air and gradient 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, propeller shaft. (5)

Unit-3

Control Systems of Automobiles:

a) Steering System:

Functions of steering system, Steering system layout, Types of automotive steering mechanisms, Types of steering gear boxes, Steering geometry-Camber, Caster, King pin inclination, included angle, Toe-in and Toe-out, Wheel alignment, Slip angle, Condition of under steer & over steer, Types and working of power steering. (5)

b) Braking System:

Requirements and functions of automotive braking system, Types of braking mechanisms Internal expanding brakes, Disc brakes, Hydraulic& Air brake systems, Servo and power brakes, Anti lock and antiskid braking, Calculation of braking force required, stopping distance and dynamic weight transfer (Numerical) (5)

Unit- 4

Study of Suspension Systems:

Objects of suspension, principles of suspension design, spring and unspring mass, types of springs, variable rate springs, torsion bars, rubber springs, shock absorbers, independent suspension, air suspension, interconnected suspension, hydro pneumatic suspension, self leveling suspension. (3)

Unit- 5

Electrical and Electronics Systems of Automobiles:

Automotive batteries, Lighting system. Starting system, Charging system, Voltage and current regulator, Electric horns and types, Dash board gauges, Wiper & side indicator Circuits, Engine electronic control modules, Microprocessors, Sensors, Safety devices, Recent developments in automobile electronics systems. (4)

Unit- 6

Automobile Maintenance: Preventive maintenance, troubleshooting and diagnosis for the systems that constitute a automobile. (2)

Term Work:

Minimum eight experiments from Group A and all experiments from Group B shall be performed

Group A:

1. Study and demonstration of four wheeler chassis layout. Two-wheel & four-wheel drive layouts.
2. Study and Demonstration of working of single plate automobile clutch.
3. Study and demonstration of synchromesh gearbox.
4. Study and demonstration of final drive and differential.
5. Study and demonstration of working Hydraulic braking system.
6. Study and demonstration of front wheel steering geometry and steering mechanism.
7. Study and demonstration of suspension system of a four-wheeler.
8. Study and demonstration of electrical charging system of automobiles.
9. Study and demonstration of electrical starting system of automobiles.
10. Study and demonstration of electric horn, fuel gauge and wiper circuit of automobiles

Group B:

1. Experiment on wheel balancing & front wheel alignment.
2. Visit to servicing station for study of vehicle maintenance, repairs and report.

Reference Books:

1) W. H. Crouse, "Automotive mechanics", Tata McGraw Hill Publishing Company Ltd, New Delhi, Ninth Edition, Delhi, 1993. ,ISBN0070634351
2) Kirpal Singh, "Automobile Engineering",Vol. II,Standard Publishres Distributors,(2009), ,ISBN8180141241
3) Narang G. B. S., "Automobile Engineering", S. Chand and Company Ltd, Fifth Edition, Delhi, 1995. Motor Vehicle: Newton & Steeds
4) Newton, Steeds and Garrett. "Motor Vehicle", The English Language Book Society, Ninth Edition, 1972.
5) Heitner Joseph, "Automotive Mechanics" CBS Publishers and Distribution, Second Edition, Delhi, 1987.
6) Automobile Mechanics: N. K. Giri
7) Automobile Engineering; R. K. Rajput
8) Automobile Engineering: K.K.Ramalingam
9) Automobile Electrical Equipment; P. L. Kohali
10) P. L. Ballaney, "Internal Combustion Engines", Khanna Publishers, Third Edition, New Delhi, 1991.
11) P. W. Gill, J. H. Smith, et.al, "Fundamental of I.C. Engines", Oxford and IBH Publishing Co. Pvt. Ltd., (2007) ,ISBN8120417100
12) Arkhangelsky V. et.al., "Motor Vehicle Engines", MIR Publishers, Mascow1976.

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B.E. (PRODUCTION) Part-1, Semester VII

ELECTIVE-I: 2. ENERGY ENGINEERING

Teaching Scheme :
Lecturers: 3 Hrs/ Week
Practicals: 2 Hr. / Alternate Week

Examination Scheme :
Theory Paper (3 Hrs.): 100 Marks
Term work: 25 Marks

Course Objective:
To understand the fundamentals of energy engineering and its applications.

Course Outcome:
The students shall demonstrate the knowledge of the fundamentals of energy engineering and its applications.

Unit-1.
Introduction:
Fossil fuel based systems, Impact of fossil fuel based systems, World scenario of Energy Resources, Indian Scenario of Energy Resources now and Renewable energy – sources and features, Distributed and dispersed energy system. (3)

Unit-2.
A) Solar Thermal System:
Solar potential, Solar radiation spectrum, Solar radiation geometry, Solar radiation data, Radiation measurement, Technologies of thermal energy collection, Applications of Solar Energy, Photovoltaic cell concepts, Operating Principle, Photo-cell materials, Cell module array, Applications. (5)
B) Fuel Cells:
Introduction, Principle and operation of fuel cells, classification and types of fuel. Fuel for fuel cells, performance characteristics of fuel cells, application of fuel cells. (4)
C) Wind Energy:
Wind parameters and wind data, Power from wind, Site selection, Construction and working of typical wind mill, characteristics of wind generators, Design considerations for wind mills, Operation and maintenance of wind mills, present status. Introduction to Ocean energy, Tidal energy, Geothermal Energy, Hybrid Systems. (5)

D) Biomass:
Introduction, Anaerobic digester, Biomass gasification, Pyrolysis, various applications of Biomass energy, Bio-fuel – Relevance, types, and applications. (3)

Unit-3
Energy Auditing
Need for energy audit, Types of energy audits, components of energy audit, energy audit methodology, analysis and recommendations of energy audit—examples of different applications, introduction to energy audit software. (7)

Unit-4.
Energy Economics
Determination of cost of steam, natural gas, compressed air and electricity. Financial analysis techniques - simple payback, Time value of money, Net present value (NPV),Return on investment (ROI),Internal rate of return (IRR), Risk and sensitivity analysis. (6)

Unit-5.

Electrical Energy Management

Electricity billing, Power factor improvement, and its benefit, Electricity act 2003, Lamp types and their features, recommended illumination levels, lighting system energy efficiency. (3)

Unit-6.

A) Cogeneration and Waste heat recovery

Cogeneration— Need, applications, advantages, classification, Commercial WHR devices, saving potential. (2)

B) CDM projects and carbon credit calculations

Introduction to CDM projects, carbon credits and its calculation, carbon foot print. (2)

Term Work:

The term shall consist of performing any Six of the following experiments.

1) Demonstration and measurement of Solar radiation.
2) Test and Trial on Solar flat plate collector.
3) Performance evaluation of PV cell.
4) Energy Audit – Case Study of an organization.
5) Visit to Wind Power plant.
6) Study and demonstration of fuel cell, application.
7) Visit to Biodiesel plant.

Reference Books:

1) Solar Energy by Dr. S.P. Sukhatme Tata McGraw Hill.
2) Non Conventional Energy Sources by G.D. Rai.- Khanna Publishers.
3) Energy Technology by S. Rao, Dr. B.B. Parulekar Khanna Publishers.
4) Energy Engineering by R.S. Kulkarni & Dr. S.V. Karmare.
5) Non Conventional Energy Sources by Dr. L. Umanand.
6) Introduction to Non Conventional Energy Resources by Raja, SciTech Publications

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B.E. – (Production Engineering) –Part-1, Semester VII

Elective – I : 3. COMPOSITE MATERIALS AND TECHNOLOGY

Teaching scheme	**Examination scheme:**
Lectures: 3 Hrs per Week	Theory Paper: (3 Hrs) - 100 Marks
Practical: 2 Hrs per week per batch	Term Work: 25 Marks

Course Objectives:

1) To introduce students the field of Composite Materials used in various engineering applications
2) To understand use and Fabrication of polymer matrix and Ceramic matrix composites
3) To study various Structural Composites
4) To study various Composite materials for optical and magnetic applications.

Course Outcomes:

1) Students will able to introduce the field of Composite Materials used in various engineering

applications

2) Students will able to understand use and Fabrication of polymer matrix and Ceramic matrix composites
3) Students will able to study various Structural Composites
4) Students will able to study various Composite materials for optical and magnetic applications.

Unit -1

Composite materials in engineering, reinforcing materials: fibers, whiskers and particles. Fiber materials for composites, Fibers of glass, boron, carbon, organic, ceramic and metallic fibers, Matrix materials, Interfaces between matrix and fibers and other dispersed phases. (6)

Unit -2

Polymer matrix composites, Characteristics and applications, Fabrication of polymer matrix composites, Metal matrix composites (MMC), Fabrication of MMCs by liquid state, solid state methods, powder metallurgy route and in site fabrication methods, Discontinuous reinforcement of MMCs, Ceramic matrix composites, Fabrication methods and applications. (6)

Unit -3

Mechanical properties in composites, large particle composites and the rule of mixtures for elastic constants, Mechanical properties of fiber reinforced composites, Effect of fiber length, Critical fiber length, Strength of continuous and aligned fiber composites, Discontinuous and aligned fiber composites, Toughening Mechanism, Impact Resistance, Fatigue and Environmental Effects. (6)

Unit -4

Structural Composites: Cement matrix composites, Steel Reinforced Concrete, Pre- stressed concrete, Thermal Control, Vibration reduction. Polymer matrix composites- vibration damping.(6)

Unit -5

Composite materials for Electrical, Electromagnetic and Dielectric applications, Microelectronics and Resistance heating, Electrical insulation, capacitors, piezoelectric, ferroelectric functions, electromagnetic windows, solid electrolytes, microwave switching. (6)

Unit -6

Composite materials for optical and magnetic applications, optical waveguide, optical filters and lasers, multilayer for magnetic applications. (6)

Term Work:

The term work shall consist of the following.

1) Assignment on study and application of engineering composites.
2) Assignment on study of Metal matrix composites.
3) Assignment on study of Mechanical properties of fiber reinforced composites.
4) Assignment on study of Structural Composite materials.
5) Assignment on study of Composite materials for Electrical, Electromagnetic and Dielectric applications.
6) Assignment on study of Composite materials for optical and magnetic applications.

Text Books:

1) Principles of Materials Science and Engineering, William F. Smith, Third Edition, 2002, McGraw-Hill

2) Composite Materials: Engineering and Science, Matthews F.L., and Rawlings R. D., 1999, Woodhead Publishing Limited, Cambridge England.
3) Composite Materials-Functional Materials for Modern Technology, DDL Chung, Springer- Verlag Publications London
4) The nature and Properties of Engg. Materials, Jastrzebaski, John Wiley & Sons, New York.

Reference Books:

1) Composite Materials Handbook, Mel M. Schwartz (R), 2nd Edition, 1992, McGraw-Hill, New York.
2) Fundamentals of Fiber Reinforced Composite Materials, A. R. Bunsell, J. Renard, 2005, IOP Publishing Ltd.
3) Composite Materials Science and Engg., Chawla K.K., Second Edition, 1998, Springer Verlag.

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B.E.(Production Engineering) -Part-I, Semester VII

ELECTIVE- I: 4. EXPERIMENTAL STRESS ANALYSIS

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hr/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term Work: 25 Marks

Course Objective:

To familiarize the students with state of the art experimental techniques namely strain gauges, photo elasticity, interferometry, coating techniques, Moire fringes and holography employed in stress analysis.

Course Outcome:

The students shall demonstrate the knowledge of the state of the art experimental techniques namely strain gauges, photo elasticity, interferometry, coating techniques, Moire fringes and holography employed in stress analysis.

Unit-1
Introductory Principles
Basic concepts of experimental stress analysis (ESA), advantages, necessity of various ESA methods, methodology of problem solving by ESA. (4)

Unit-2
Strain Measurement Techniques
Introduction to strain measurement, Review of stress, strain and Hooke's law, Definition of stress and strain tensors, Strain gauges, Properties of strain gauge systems, Types of strain gauges, Mechanical and Optical strain gauges, Electrical strain gauges, LVDT, resistance strain gauges, Gauge factor, Materials for adhesion base etc, Recording instruments, static and dynamic recording. (8)
Strain Analysis Methods
Three element rectangular strain rosette, correction, stress gauges, over-deterministic methods for strain analysis, residual stress determination, Applications of strain gauges for measurement of load, temperature, pressure, vibration, stress and strain. (4)

Unit-3

Optical methods of Stress Analysis

Basics of optics, Optical instrumentation, Moire fringe technique – theory and experimental procedures, Fractional fringe measurement, Tardy's method, Babinet Soleil method. (5)

Unit-4

Theory of Photo elasticity – Two dimensional photo elasticity

Introduction, Temporary double refraction, Polariscope – Plane and Circular, Stress optic law, Different arrangements, photo elastic photography, properties of photo elastic materials, Selection, casting methods, calibration. Analysis techniques – determination of direction of principal stresses at a given point, determination of exact fringe order N and the principal stress separation methods, Method based on Hooke's law, Electrical analogy method, Shear difference method, Model to prototype scaling. (8)

Unit-5

Three dimensional photo elasticity

Stress freezing method, General slice, Effective stresses, stress separation, Shear difference method, Secondary principal stresses, Scattered light photo elasticity (5)

Unit-6

Coating Methods

Birefringent coating techniques, Stress-optic and strain-optic relation, Sensitivity and coating materials, Fringe order determination, Brittle coating technique, Moire technique. (4)

Holography

Introduction, Plane and spherical waves, coherence, holographic set-up, Interferometry – Displacement measurement, Isopachics. (2)

Term Work:

Minimum six assignments based on the above topics including two exercises involving analysis.

Text Books:

1) Dally and Riley, "**Experimental Stress Analysis**", McGraw Hill Book Company, 1991.
2) L. S. Srinath, "**Experimental Stress Analysis**", Tata McGraw Hill Book Company, New Delhi, 1984.
3) Sadhu Singh, "**Experimental Stress Analysis** ", Khanna Publishers, New Delhi, 1996.

Reference Books:

1) Holman, "**Experimental Methods for Engineers**", 7th Edition, Tata McGraw Hill Book Companies, Inc, New York, 2007

2) R.S Sirohi, H.C. Radhakrishna, " **Mechanical Measurements**", New Age International Pvt. Ltd, New Delhi, 2004.

3) Perry and Lissner, "**Strain Gauge Primer",** McGraw Hill, 1962.

4) Doeblin E. A.,"**Measurement Systems Application and Design**", McGraw Hill, New York, 1989

5) M.M. Frocht, "**Photoelasticity Vol I and Vol II**" John Wiley and Sons, 1969.

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ELECTIVE-I: 5. SAFETY ENGINEERING

Teaching Scheme:
Lecture 3 hrs/week
Practical 2 hrs/week

Examination Scheme:
Theory Paper (3 Hrs.): 100 marks
Term work 25 marks

Course Objectives:
To understand the fundamental concepts of safety engineering and learn the techniques for identification and control of industrial hazards

Course Outcome:
The student shall demonstrate the knowledge of fundamental concepts of safety engineering and the techniques for identification and control of industrial hazards

Unit-1
Industrial safety, Hazard identification and risk assessment, Preliminary hazard analysis (PHA), Failure mode effect analysis (FMEA), Job Safety Analysis, Accident causation, Accident investigation, Root cause analysis (6)

Unit-2
Safe design of plant layout and facilities, Emergency response preparedness, Designing safety features in machine and equipment, Poka-yoke for safe design and operation, Machine and equipment guarding, Personal protective equipment (6)

Unit-3
Foundry processes: Effects of heat, dust, and noise on worker fatigue and productivity, Working in hot environment, Hazards and safety precautions in melting, moulding, core making, fettling, and foundry material handling (6)

Unit-4
Metalworking processes: Hazards in hot forging and rolling operations, Safety in handling, storage and changeover of dies and rolls, Safe use of power presses, Safety precautions in shearing bending, rolling, drawing and other metalworking processes (6)

Unit-5
Machining processes: Designing safety features in machine tools, Common hazards in machining processes and their control. Safety in design and operations of material handling equipment. Industrial robots and robot system safety, Work envelope of robots, Sources of hazards in robot operations, Safeguarding personnel. (6)

Unit-6
Safety in maintenance operations, Work Permit Systems, Work in confined spaces, Working at height, Fabrication processes: Hazards in welding operations and their control. (6)

Term Work:
Any six of the following assignments, with an emphasis on obtaining and using field data.
1) Preliminary hazard analysis of a workplace
2) Failure mode effect analysis of a workplace and calculation of risk priority number

3) Improving design of a machine/ equipment using poka-yoke principles
4) Visit to a foundry and identification and classification of hazards
5) Visit to a forging/ rolling industry and identification and classification of hazards
6) Study of safety features of a robotic system
7) Study of safety features of material handling systems

Reference Books:

1) Industrial Accident Prevention, H W Heinrich, McGraw Hill, 1980
2) Occupational Safety Management and Engineering, W Hammer and D Price, Prentice Hall, 2000
3) Occupational Safety and Health: For Technologists, Engineers, and Managers. D Goetsch, Prentice Hall, 1999
4) Probabilistic Risk Assessment and Management for Engineers and Scientists, H Kumamoto and E Henley, IEEE Press, 1996

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ELECTIVE- I : 6. RAPID PROTOTYPING

Teaching Scheme:
Lectures: 3 Hrs. / Week Theory
Practicals: 2 Hrs. / Week/ Batch

Examination Scheme:
Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objective:
To study the concepts and applications of rapid prototyping and rapid manufacturing

Corse Outcome:

The students shall have the knowledge of concepts and applications of rapid prototyping and rapid manufacturing.

Unit-1

Introduction to Rapid Prototyping:

Definition of rapid manufacturing (RM), rapid prototyping (RP) and rapid manufacturing, areas of application. Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification, RP Processes: Process overviews, STL file Generation, File Verification &Repair, Build File Creation, Part Construction, Part Cleaning and finishing, Process Strength & limitations. (6)

Unit- 2

Design Potential of Rapid Prototyping:

Conventional design for manufacturing and assembly (DFM, DFMA), impact of RM on DFA and DFMA, Geometrical freedom, design complexity/ optimization, parts consolidation, body fitting customization and multiple assemblies manufactured as one, Customer input and customization, CAD environment for RM. (6)

Unit- 3

Rapid Prototyping Processes-I:

a. Stereo lithography **(SLA):** Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages.
b. Laminated Object Manufacturing **(LOM):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.
c. Fused Deposition Modeling **(FDM)**: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. (6)

Unit- 4

Rapid Prototyping Processes-II:

a. Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.
b. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.
c. Laser powder forming: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. (6)

Unit- 5

Materials in RM:

Issues, viscous flow, photo-polymerization, sintering, infiltration, mechanical properties, Materials for RM processes, Prototype properties: Material properties, color, dimensional accuracy, stability, surface finish, machinability, Functionally graded materials (FGM composites), processing technologies for FGMs, thermal and mechanical properties of FGM, Deposition systems and applications. (6)

Unit- 6

Applications of RP:

Form and fit checking, Ergonomic Studies, Functional testing, Automotive applications- Parts ofracing cars, Applications in Aerospace industry, Construction industry, Applications in Medical field , Rapid Tooling: Mold making, Rapid tooling for die, permanent mold casting, Rapid manufacturing of sheet metal forming tools, casting pattern plates by rapid tooling, RP for series production investment casting. (6)

Term Work:

1) Three Assignments on 3D modeling & STL File generation of industrial components.
2) Assignment on introduction to Rapid manufacturing
3) Study of RP Processes along with working principles, set up, applications, advantages and limitations
4) Assignment on applications of rapid prototyping in various fields like automotive, aerospace, medical, construction etc.
5) Assignment on rapid tooling along with working principles, setup, applications, advantages and limitations

Reference Books:

1) Rapid Manufacturing: An Industrial Revolution for the Digital Age – Editors N.Hopkinson, R.J.M. Hague and P.M. Dickens, (2006) John Wiley & Sons, Ltd., ISBN-10 0-470-01613-2
2) T. A. Grimm & Associates, Users Guide to Rapid Prototyping, Society of Manufacturing Engineers (SME) ISBN 0872636976

3) Frank W. Liou, Rapid Prototyping & engineering applications, CRC Press, ISBN 978-0-8493-3409-2
4) Rapid Prototyping theory & practice, Manufacturing System Engineering Series, Ali K. Kamarani, Springer Verlag
5) Rapid Prototyping- case book, J. A. McDonalds, C. J. Ryall, Wiley Eastern
6) Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern
7) Carmen Gabriela BĂCILĂ, Zoltan-Gabor BAKI-HARI , " The Main Applications of Rapid Tooling," RECENT, Vol. 8, nr. 3a(21a), November, 2007
8) ANNALS of the ORADEA UNIVERSITY. Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007
9) John F. Wallace, David Schwam," Rapid manufacturing of sheet metal formingtools," Case Western Reserve University
10) A. Pereira, J.A. Pérez, J.L. Diéguez, G. Peláez and J.E. Ares, "Design and manufactureof casting pattern plates", by rapid tooling, Archives of Materials Science, Vol. 29, No. 1-2, 2008 63
11) Using RP for Series Production Investment Castings, Tom Mueller, Express Pattern

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ELECTIVE-I : 7. RELIABILITY ENGINEERING

Teaching Scheme:
Lecture 3 hrs/week
Practical 2 hrs/week

Examination Scheme:
Theory Paper (3Hrs): 100 marks
Term work 25 marks

Course Objective:
To understand fundamental concepts of reliability and learn the models for component and system reliability.

Course Outcome:
The students shall have the knowledge of fundamental concepts of reliability and the models for component and system reliability.

Unit-1
Introduction to reliability, Definitions, Reliability in product life-cycle, Quality, Failures, Failure data, Failure models, Causes of failures, Maintainability and availability, System effectiveness, Redundancy techniques (4)

Unit-2
Probability, Axiomatic probability, Statistical probability, Rules of probability, Random variables, Discrete distributions: Binomial and Poisson distribution, Continuous distributions: Uniform, Exponential, Weibull, Normal, Rayleigh, Gamma distribution (6)

Unit-3
Component reliability, Mean time to failure (MTTF), Time-dependent hazard models: Field-data, Constant hazard, Linear hazard, Nonlinear hazard, Gamma model, Stress-dependent hazard models, Markov model (8)

Unit-4
System reliability, Components in series, Components in parallel, k-out-of-m systems, Mixed-mode failures, Fault-tree technique, Failure mode effect analysis (FMEA), Risk priority number (RPN) (8)

Unit-5
Maintainability function, Mean time to repair (MTTR), Availability function, Preventive maintenance, Redundancy techniques, Unit redundancy, Component redundancy, Weakest-link technique, Mixed redundancy, Standby redundancy (6)

Unit-6
Economics of reliability, Manufacturer's cost, Customer's cost, Reliability achievement cost, Reliability utility cost, Depreciation cost, Availability cost for parallel systems (4)

Term work:
Any six of the following assignments, with an emphasis on obtaining and using field data.

1) Plotting bath-tub curve using failure data of a machine/equipment/system
2) Estimation of parameters of statistical distribution from failure data of a machine
3) Calculation of hazard rate of a system using appropriate hazard model
4) Estimation of failure rate and system reliability using fault-tree diagram
5) Comparison of system reliability applying different redundancy techniques
6) Estimation of MTTF, MTTR, and availability of a machine from failure data
7) Failure mode effect analysis for an equipment/system and estimation of risk priority number

Text Books:
1) Reliability Engineering and Life Testing, V N A Naikan, Prentice Hall, 2008
2) Reliability Engineering, E Balagurusamy, Tata McGraw Hill, 2008

Reference Books:
1) Principles of Reliability Engineering, K B Misra, Reliability Engineering Centre, IIT Kharagpur, 2004.
2) Maintenance Engineering and Management, S K Srivastava, S Chand, 2008
Terotechnology: Reliability Engineering and Maintenance Management, B Bhadury and S K Basu, Asian Books, 2003.

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6. INDUSTRIAL TRAINING

Teaching Scheme:
Not Applicable.

Examination Scheme:
Term work: 25 Marks
External Oral Examination: 25 Marks

Course Objective:
To expose the students to industrial work systems and working environment.

Course Outcome:
The students shall have the knowledge of industrial work systems and working environment.

Term Work:
Every student shall prepare a report of the industrial training and the case studies carried out during at least a 15 days vacational in-plant training in a prescribed format under the guidance of the Project Guide, before end of Part I, semester VII. The report shall be comprehensive and presented in duplicate, typed on standard A4 size sheet and bound. This will form the term work.

The Training Contents:
The student shall undergo training program prepared by the industry in following manufacturing and functional area.

1) Plant Engineering: Plant Layout, Plant Maintenance, Housekeeping, Material Handling & safety.
2) Production Planning And Control, Quality Assurance.
3) Material Management: Inventory Control, Vendor Development, Vendor Rating, Raw
4) Material and Finished Goods stores.
5) Manufacturing Processes: Machines & Equipments, Its working, Machine / Process Diagnosis.
6) Industrial Engineering: Method Study, Work Measurement, Ergonomics and Productivity
7) Improvement Technique.
8) Costing and Cost Control.
9) Management Information System (M.I.S.). /Enterprise Resource Planning (ERP) System.
10) Incentive Schemes, Labor Laws. Factory Acts.
11) Quality Assurance, Quality Improvement.
12) Improvement in tool layout, tool selection machine selection.
13) Maintenance of machines, housekeeping, safety precautions.
14) Computer based information study for stores, purchase wastage of material, In process
15) Material planning and scheduling, assembly of storage of finish product dispatch.

The students shall submit a detailed report on his/her in-plant training including case studies.

Notes: The Reports of students undergoing training in the same organization must include different case studies. The project guide shall assess the term work.

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7. PROJECT WORK- Phase-I

Teaching Scheme:
Practical: 4 Hrs./Week/Batch

Examination Scheme:
Term work: 75 Marks

Course Objective:
To prepare the students to carry out a comprehensive study of any design or process or phenomenon, to encourage the process of independent creative thinking and working in groups and to expose them to industrial atmosphere of accountability.

Course Outcomes:
The students shall have the ability to carry out a comprehensive study of any design or process or phenomenon as well as independent creative thinking and working in groups with exposure to industrial atmosphere of accountability.

Term Work:
The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The work started in Semester VII will be continued in the Semester VIII and the final submission of the report will be at the end of the Semester VIII.

The project work may consist of-
1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Design of any equipment and / or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing it.
4. Experimental verification of principles used in applications related to Production or Mechanical Engineering.
5. A combination of the above.

A synopsis of the selected project work (two to three pages typed on A4 size sheets) will be submitted and assessed by the Project Guide and one more faculty member appointed by the Department / concerned responsible official of the sponsoring industry/Co-guide.
The work to be completed in Semester VII shall include-
a) Problem Identification
b) Methodology / Design Documents
c) Activity planning for the time frame and **division of responsibility to each student**. An interim report of the work completed in Semester VII in the form of workbook /project diary and other relevant documents shall be submitted for the term work. The term work shall be assessed by the Guide and one more faculty member appointed by the Head of the Department. The assessment shall be based on a presentation of the work completed and submission of interim report.
The oral examination shall be based on the work planned and actually completed in Semester-VII.

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1. COSTING AND COST CONTROL

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objectives
1) To gain the fundamental knowledge about the costing system.
2) To understand the process of costing for different industries.
3) To learn the cost accounting methods.
4) To learn the techniques of costing in cost control and cost reduction areas.

Course Outcomes
1) The student shall demonstrate the fundamentals of Costing System.
2) The student shall apply the costing methods based on type of industry.
3) The student shall be able to apply the different Cost accounting methods as per requirement.
4) The student shall demonstrate his acquired skills in Cost control and Cost Reduction.

Unit-1

Cost and Cost Estimation: Concept of cost, cost unit, cost center, classification of cost, elements of cost, Definition of costing, desirable conditions for a costing system. Cost sheet. Cost Estimating**:** Definition, purpose and functions of estimation, role of estimator, constituents of estimates, estimating procedures.(5)

Unit-2

Estimation of Weight and Material Cost: Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost. Purchasing procedure, Inventory Valuation by LIFO, FIFO, Weighted average method. (8)

Unit-3

Estimation of fabrication, foundry, forging and machining cost

Constitutes, direct cost, indirect cost, Procedure of estimation of cost for each type. Machine hour rate: definition, constituents, direct cost, indirect cost, steps for estimation of machine hour rate for conventional machines, CNC lathe and machining center. (6)

Unit-4

Overheads: Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, absorption of overheads. (6)

Unit-5

Cost Accounting Methods: Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing. (5)

Unit-6

Cost Control: Budget and budgetary control, standard cost, variance analysis, Cost Reduction Areas: Value analysis and Value engineering, Zero Base Budgeting, Cost Volume profit Analysis, Profit volume ratio (5)

Note: Numerical treatment on units1, 2, 3, 4 and 5 is essential.

Term Work:

Note: Use of computers is essential for at least one exercise.

1. Estimation of weight and material cost for an assembly of three to five components.
2. Valuation of inventory by LIFO, FIFO, Weighted average method
3. Estimation for machine hour rate for representative machines – one conventional machine and one CNC lathe or machining center.
4. Case study on estimation of overheads for a manufacturing unit
5. Study of different methods for allocation, apportionment, absorption of overheads
6. Case study in any one industry using any of the method of costing.
7. Different examples illustrating cost control
8. Case studies of cost reduction

Reference Books:

1. Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
2. Costing Simplified: Wheldom Series – Brown &Owier (ELBS)
3. Cost Accounting: B. Jawaharlal (TMH)
4. Cost Accounting: R.R. Gupta.
5. Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)
6. Cost Accounting: Jain, Narang (Kalyani Publishers)
7. A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)

8. Mechanical Estimation and Costing – TTTI, Chennai (TMH)
9. Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH)

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2. INDUSTRIAL ENGINEERING

Teaching Scheme
Lecture: 3hrs/week
Practical: 2hrs/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs.): 100 marks
Term work: 25 marks
External Oral Examination: 25 Marks

Course Objective:
To acquire interdisciplinary knowledge of method study, work measurement techniques and ergonomics for the overall improvement of productivity and effectiveness.

Course Objective:
The student shall demonstrate an interdisciplinary knowledge of method study, work measurement techniques and ergonomics for the overall improvement of productivity and effectiveness.

Unit-1
Introduction to Productivity and Work Study: Definition and scope, Productivity and quality of life, Evolution of work study, contribution of Taylor and Gilbreth, Work study techniques and basic procedure, Human factor in application of work-study.
Method study:
a) Definition, objectives and basic procedure.
b) Record, Examine, Develop – Process chart symbols, Outline and flow process charts, Flow diagrams, Critically Examine Techniques
c) Movement of workers and material – string diagram, flow process charts worker Material and equipment type, multiple activity chart – Man – Machine, Machine- Machine chart, Travel charts for workplace
d) Methods and Movements at workplace- Principles of motion economy, Classification of movements, Two handed process chart, SIMO chart, Micro Motion study, Therbligs.
e) Evaluate, Define, Install and Maintain methods (12)

Unit-2
Working conditions and Environment: Occupational hazards, health and safety, housekeeping, lighting, noise and vibrations, climatic conditions, ILO norms
Ergonomics: Human factor engineering, man- machine interaction, **Design of controls, environment factors, Anthropometry, workplace design.** (5)

Unit-3
Value Engineering: Introduction, Concept, Difference between Value Engineering and Value Analysis, Case study. (2)

Unit-4
Work Measurement:
Definition, objectives, basic procedure, Techniques of work measurement, Time study – Equipment and forms, selection of a job, steps in time study, breaking the job into elements, timing the elements; Rating

in time study – standard rating and standard performance, factors affecting rate of working, standard time determination, use of time standards, allowances;
Work sampling – Need, procedure for work sampling, determining time standard by work sampling.
Predetermined time standards (PTS) – definition, methods time measurement (MTM) standard data from PTS, applications of PTS
MOST (Maynard Operation Sequence Technique) – Introduction, Methodology (9)

Unit-5
Location Layout:
Factors affecting site selection, factors affecting layout design, types of layout, systematic layout planning procedure, travel chart, information gathering, flow analysis and activity analysis relationship diagram, space requirement and availability, designing of layout – use of CAD; Material Handling Systems– Principles, functions and equipments, **selection of MH systems, unit load concept in MH, Economics of material handling.** (5)

Unit-6
Job Evaluations and Merit Rating: Job analysis, Ranking system, Grade description system, Point system, Factor comparison system; Method of merit rating systems,
Incentives: Types of Incentives, Relationship of motion and time study with the incentives. (5)

Term Work:
1. At least one industrial visit to study applications related to the subject and submission of the relevant report.
2. Method study with present and proposed methods for a manufacturing related task
3. Design and drawing of work place layout in a manufacturing environment considering Ergonomics factors
4. Industrial case study on Plant layout design.
5. Time study for a processing operation on a job and calculation of standard time
6. One experiment on micro motion study with the help of video camera./ Case study on Job & merit rating/ Case study on relationship of motion & time study with incentives.
7. A case study on Value Engineering.

Reference Books:
1. Work Study: - I L O
2. Work Study: - Curie and Faraday (ELBS)
3. Industrial Engineering Handbook, Maynard (Mc Graw Hill)
5. Time and Motion Study Design, Barnes, R.M. (John Wiley)
4. Work Study & Ergonomics, L.C. Jhamb (Everest)
5. Facility Layout and Location – An Analytical Approach, Francis et. al.(PHI)
6. Facilities Planning – 3/e, Tompkins, White, Bozer, Tanchoco (John Wiley & Sons)
7. Job Evaluation - ILO
8. Payment by Results, - ILO
9. Work Study by O.P. Khanna (Dhanapat Rai and Sons)

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3. FINITE ELEMENT ANALYSIS

Teaching Scheme:
Lectures: 4 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks
External Practical Examination: 25 Marks

Course Objectives:

1) To understand Finite Element Methods
2) To develop an ability to-
   a) Analyze 1D, 2D structural analysis problems
   b) Analyze thermal analysis problems
   c) Use of translators for import export of CAD models.

Course Outcomes:

At the end of this course, Students are able to-

1. To calculate deflection, stress and strain in structural analysis
2. To calculate temperature at various nodes
3. To select and use appropriate translator for CAD data.

Unit-1: Introduction to Finite Element Method: Basic Concept, Historical Background, Engineering applications, general Description, comparison with other methods. **Integral Formulation and Variation Methods:** Need for weighted-integral forms, relevant mathematical concepts and formulate, weak formulation of boundary value problems, variational methods, Rayleigh-Ritz method and weighted residual approach. (8)

Unit-2: Finite Element Techniques: Module boundary value problem, finite element decartelization, element shapes, sizes and node locations, interpolation functions, derivation of element equations, connectivity, boundary conditions, FEM solutions, post processing, Compatibility and completeness requirements, convergence criteria, higher order and isoparametric elements, natural coordinates, Lagrange and Hermit Polynomials. (10)

Unit-3: Fundamental of Solid Mechanics : concepts of Stress Strain Curve, true stress, true strain, stress tensor, strain tensor, Plane stress and strain, Principal stress and strain, yield criteria- Tresca and Von Mises
Analysis of 1D element: Analysis of Spring Element: stiffness matrix, displacement, stress
Analysis of Link element: 1d link, Matrix formation, Calculations of displacement, stress and strain. (12)

Unit-4: Analysis of 2D truss element: Calculations of displacement stress and strain. Analysis of 2D plane element, Calculation of stress, strain (10)

Unit-5: Applications to Heat Transfer Problems: Variational approach, Galerikn approach, one dimensional and two dimensional steady state problems for conduction, convection and radiation, transient problems. (5)

Unit-6: Standards for CAD: Need, Graphics and Computing standards, Data Exchange standards, Communications Standards (3)

Term Work:

1. Analysis of spring element using any suitable software
2. Analysis of bar element using any suitable software package
3. Analysis of 2D spar truss any suitable software package
4. Area meshing exercise
5. Study of translators
6. At least two meshing exercises based on free and mapped meshing
7. Mini-project based on CAD and CAE software#.

Any type of case study using CAD, CAE software can be considered for Mini-project.
External oral should be based on term-work only.

Reference Books:

1. "Introduction to Finite Elements in Engineering"; Chandrapatala, Belgundu, PHI.
2. "Finite Element Methods for Engineers"; U.S. Dixit, Cengage Learning.
3. "An Introduction to Finite Element Method"; J. N. Reddy; 2/e, McGraw Hill International Editions, ISBN 0-07-112799-2
4. "Finite Element Analysis – Theory and Practice"; M.J. Fagan, Longman Scientific & Technical.
5. "The Finite Element Method – Basic Concepts and Linear Applications"; O. C, Zienkiewicz; McGraw Hill International Editions; ISBN 0-07-084175-6
6. "Practical Finite Element Analysis", N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N. Thite, Finite to Infinite Publication.
7. The Finite Element Method For Engineers – Huebner Willy India
8. Concepts of Finite Element Methods by Manicka Selvam SCITECH publication
9. A First Course in the Finite Element Analysis By D.L.Logan CENGAGE Learning
10. User manual of concerned analysis software package.

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ELECTIVE- II : 1. PRODUCT DESIGN AND DEVELOPMENT

Teaching Scheme:
Lectures: 3 hrs/week
Practicals:2 Hrs./Batch/Week

Examination Scheme:
Theory Paper (3 Hrs.): 100 Marks
Term Work: 25 Marks

Course Objectives:

To understand the basic as well as the advanced knowledge of product design and development process and its application.

Course Outcomes:

The students shall demonstrate the knowledge of basic as well as the advanced product design and development process and its application.

Unit-1

Introduction to Product Design & Development:

Definition Of Product Design, Design By Evolution And Innovation, Factors In Product Design, Morphology Of Product Design (Seven Phases), Standardization, Simplification and Specialization In

Product Design, Modern Approaches- Concurrent Design and Quality Function Deployment (QFD), Product Development, Product Development versus Product Design, Types Of Design And Redesign, Modern Product Development Process, Product Development Team And Product Development Planning With Reference To ISO Standard, Difference Between Product Verification And Production Validation, Introduction To Prototyping, Rapid Prototyping Methods. (6)

Unit- 2

Product Development - Technical and Business Concerns:

Technology Forecasting and Technology S-Curve (Technology Stage), Mission Statement and Technical Questioning, Economic Analysis of Product, Customer Needs and Satisfaction, Customer Population and Market Segmentation, Customer Needs-Types and Models, Gathering Customer Needs Information, Analysis *of* Gathered Information. (6)

Unit- 3

Product Development from Concept to Product Function:

Generating concepts, information gathering, and brainstorming, morphological analysis, concept selection-design evaluation, estimation *of* technical feasibility, concept selection process, Pugh's concept, selection charts, numerical concept scoring, process of concept embodiment, system modeling, FMEA, functional modeling and decomposition, fast method, subtract and operate procedure, establishing system functionality, augmentation and aggregation. (7)

Unit-4

Product Development in the Context of Reverse Engineering:

Product Teardown Process, Tear Down Methods - Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used In Benchmarking - Indented Assembly Cost Analysis, Function -Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture. (7)

Unit-5

Design for Manufacture, Assembly and Environment:

Design guidelines, design for manufacture, design for assembly, design for piece part production, manufacturing cost analysis, need and importance of design fo*r* environment, global, local and regional issues, basic DFE methods-guidelines and applications, life cycle assessment - basic method, weighed sum assessment method, life cycle assessment method, DFX, product testing, product validation, field trials, virtual trials, iterations. (7)

Unit-6

Introduction to Product Life Cycle and Product Data Management:

Background, Overview, Need, Benefits, and Concept of Product Life Cycle, Components/Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Product Data and Product Workflow, The Link Between Product Data and Product Workflow, Different Phases of Product Life Cycle and corresponding technologies. Reliability concepts in product development. (7)

Term Work:

The term work shall consist of total Six assignments based on each of the above mentioned units.

Text Books & Reference Books:

1) Kevin Otto and Kristin Wood" Product Design: Techniques in Reverse Engineering and New Product Development," Pearson Education Inc.
2) A.K. Chitale; R.C. Gupta, "Product Design and Manufacturing" Prentice Hall India

3) Dieter George E., "Engineering Design" McGraw Hill Pub. Company, 2000.
4) Grieves, Michael" Product Lifecycle Management", McGraw-Hill, 2006. ISBN0071452303
5) Bralla, James G Handbook of Product Design for Manufacturing, McGraw Hill Pub.1986
6) ISO Standard: 9001:2008: Clauses 7.1, 7.2, 7.3
7) Kevin Otto and Kristin Wood, ―Product Design – Techniques in Reverse Engineering and New Product Development‖, Pearson Education, 2004.
8) Karl T Ulrich and Stephen D Eppinger, ―Product Design and Development‖, McGraw Hill, 1994.
9) Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006. ISBN0071452303
10) Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management, Springer, 1st Edition (Nov.5, 2003)
11) Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105

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ELECTIVE -II: 2. ADVANCED MACHINE DESIGN

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hr/Week/Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term Work: 25 Marks

Course Objectives:

1) To understand the fundamentals of elasticity in comparison with the mechanics of deformable bodies.
2) To develop systematic knowledge of basic concepts like stress, strain, equilibrium, compatibility and failure theories.
3) To relate the stresses and strains in terms of elastic constants and understand the importance of these constants.
4) To become acquainted with the fundamental concepts of stress analysis in two dimensions using stress functions.
5) To understand the behaviour of prismatic bars subjected to torsion.
6) To understand the concept of strain energy and the relevant energy methods for the solution of engineering problems.

Course Outcomes:

At the end of this course the students will be able to -

1) Be proficient with the basic concepts of elasticity and understand the limitations of the 'Strength of Materials'.
2) Apply the analytical techniques to :(i) determine internal forces, stresses and strains (ii) predict failure of simple components.
3) Characterize materials with elastic constitutive relations.
4) Obtain solutions to simple beam problems (cantilever, simply supported) using stress functions.
5) Seek stresses in prismatic bars subjected to torsion (using membrane, soap-film analogy).
6) Utilize the energy methods and obtain solutions to elastic bodies subjected to various loads.

Unit- 1

Analysis of Stress:

Basic concepts: Body force, Surface Force, Stresses, Components of Stresses, State of stress at a point, Stress components on an arbitrary plane, Principal stresses, Shear stresses, Stress transformation, Introduction to Mohr's circle, Plane stress, Differential equations of equilibrium, Boundary conditions, Stress invariants, Octahedral stresses, Decomposition of a state of stress. (9)

Unit- 2

Analysis of Strain:

Deformation, Strain displacement relations, Strain components, State of strain at a point, Dilatation, Compatibility conditions, Plane strain (5)

Unit- 3

Stress- Strain relations:

Generalized Hooke's Law in terms of elastic constants, Relations between elastic constants, Displacement equations of equilibrium, Saint Venant's principle. (4)

Unit- 4

Two dimensional problems in Cartesian co-ordinates:

Airy's stress function, Biharmonic equilibrium equations, Study of simple beam problems: (a) Bending of a cantilever beam with end load, (b) Simply supported beam with uniform load. (4)

Unit- 5

Analysis of axi-symmetric problems and Torsion:

Axi-symmetric problems: General equations in polar co-ordinates, Thick-walled cylinder subjected to external and internal pressure

Torsion: Torsion of prismatic (circular and elliptical cross-section) bars, Soap film logy. (6)

Unit- 6

Energy Methods:

Concept of elastic strain energy, Strain energy due to axial force, shear force, torsion, bending moment, Principle of superposition, Maxwell-Betti-Rayleigh reciprocal theorem, Castigliano's theorems, Principle of virtual work. (8)

Term Work:

Minimum six assignments based on the above topics including two exercises involving analysis (Analytical or FEA) and design modification for a component.

Text Books:

1) S. P. Timoshenko and J N Goodier, "**Theory of Elasticity**", McGraw Hill Book Company.
2) L. S. Srinath, "**Advanced Mechanics of Solids**", Tata McGraw Hill Book Company.
3) Richard G Budynas, "**Advanced Strength and Applied Stress Analysis",** McGraw Hill , New Delhi, Second Edition, 2011.

Reference Books:

1) Sadhusingh, "Theory of Elasticity", Khanna Publishers, New Delhi, Fourth Edition, 2012.
2) Wang C. T. , "Applied Elasticity", McGraw Hill, New Delhi, 1990.
3) L. D. Landau and E. M. Lifshitz, "Theory of Elasticity", Vikas Publishing House Pvt. Ltd, New Delhi.
4) T. G. Sitharam, "Applied Elasticity", Interline Publishing.
5) Phillips, Durelli and Tsao, "Analysis of Stress and Strain" McGraw Hill Book Company.

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Elective- II: 3. ADVANCED TOOL & DIE DESIGN

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective:
To study principles of designing fixtures and dies for industrial applications.

Corse Outcome:
The students shall have the knowledge of the principles of designing fixtures and dies for industrial applications.

Unit-1
Introduction: Jigs and Fixtures, Flexible Fixture, Materials for Tools, Fixture and Dies.**. Modular Fixture Systems**: Development of modular fixtures, T- slot based and Dowel pin based Modular Fixture systems, Interactive Computer Aided Fixture Design (I-CAFD) Structure, Locating / clamping Model Analysis and classification, Fixture Component Selection, Fixture component Assembly Manipulation. (9)

Unit-2
Group Technology based Computer Aided Fixture Design: Fixture Design process analysis, Fixture Structure Analysis, Fixture Feature Analysis, Fixture Design Similarity Analysis, Representation of Fixture, Feature information, Automated Fixture configuration Design. (6)

Unit-3
Geometric and Accuracy Analysis: Geometric constraint conditions, Assembly Analysis, 3-D Fixture configurations, Locating Accuracy and Error analysis, clamp planning, Machining accuracy analysis. (5)

Unit-4
Basic Principles of Metal Forming: Flow conditions and flow curve, Deformation and material flow, force and work, Formability.**Die Design for Hydro Forming:** Process Technology, Die design considerations, die layout, die clamping, lubricants. (8)

Unit-5
Die Design for Deep Drawing and Stretch Drawing: design considerations, die materials, efforts of friction, wear and lubrication, Die handling, Die clamping, dies for hydro mechanical deep drawing. (5)

Unit-6
Extrusion Dies: Die Design for metal and plastic extrusion, die materials, die clamping, die handling, Dies for Solid Sections, Dies for hollow section. (7)

Term Work:
The term work shall consist of all of the following assignments.

1) Case Study of T- Slot based Modular Fixture system.
2) Case Study of Dowel pin based Modular Fixture system.
3) Computer Aided Fixture Design for Simple Component.

4) Die Design for stretch drawing operation for a component.
5) Extrusion die design for solid section in plastic.
6) Study of die clamping systems for various processes.

Reference Books:

1) Rong, Yeming; "Computer Aided Fixture Design", Marcel Dekker, ISBN 0-8247-9961-5
2) Metal Forming Handbook – Schuler, Springer- Verlag Berlin.
3) Dies for Plastic Extrusion – M.V. Joshi – Mc Millan.
4) Tool Design – C. Donaldson, LeCain & Goold (TMH)
5) Tool Design – H.W. Pollack (Taraporwalla)
6) ASM Handbook – Forming – ASME
7) Handbook of Die Design, 2/e – Suchy, I (McGraw Hill), 2006.
8) Design of Jigs and Fixtures – Hoffman (Pearson)
9) An Introduction to Jig & Tool Design, M.H.A. Kempster, (ELBS)
10) Jigs and Fixture Design Manual, Henrikson (Industrial Press, NY)
11) Die Design Fundamentals, J. R. Paquin, R. E. Crowley, Industrial Press Inc.
12) Jigs & Fixtures; Design Manual – (2/e), P.H. Joshi, (TMH) (2003)

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Elective-II: 4. MATERIAL HANDLING SYSTEMS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective
To study material handling equipments their selection, design concepts and applications.

Course Outcome:
The students shall have the knowledge of material handling equipments their selection, design concepts and applications.

Unit-1
Introduction: Definition, scope, basic concepts, principles of material handling, economics of handling, Concepts of unit load, containerization and palletization. **Facilities Design Function:** Scope, objectives and types; relationship of plant layouts with material handling, factors to be considered for plant layout design; Space planning for various activities like office, storage, and production etc., factors - area allocation, location, relative positions, future expansion. (10)

Unit-2
Material Flow: Operation sequence, material flow pattern, Part flow analysis in group technology, stages of material flow - at receiving, in process and at shipping, flow planning criteria and design of flow pattern. (5)

Unit-3
Warehousing: Concept, Types, Storage and design considerations for in-house warehouses. (2)

Unit-4

Equipment for Material Handling Systems for Various Materials:

a) Storing equipments like pallets, bins, racks, decking, order picking, positioning equipments. (4)

b) Hoisting equipment like jacks, pulleys, hand trolleys, hoists, power hoist, various types of cranes and elevators. (3)

c) Equipment for Material Movement: i) Conveying equipments like belt, chain, roller, wheel, trolley, tray conveyors, gravity and vibratory type conveyors, screw conveyors. (3)

ii) Mobile equipment like hand trucks, fork lift trucks, powered industrial trucks and tractors, powered stackers, reach trucks, order pickers. (3)

Unit-5

Design and Selection of M. H. Equipment: Factors affecting, procedure for selection, design of conveyor, electric hoist, case studies (4)

Unit-6

Automated Material Handling: Need, Comparison with conventional systems, equipments like industrial robots and automatically guided vehicles, ASRS, use of simulation software for design of m. h. system. **Safety and Training:** Need, environmental and human factors in material handling. (5)

Term Work:

Assignments Sr. no. 1 to 4 shall consist of the industrial case studies.

1. Study of Facility design
2. Study of Material flow analysis
3. Study of Storing and hoisting equipments
4. Study of Conveying and mobile equipments
5. Selection of M.H. equipments and design of conveyor/electric hoist.
6. Exercise on design / simulation of M.H.S. using simulation software like FLEXSIM or similar
7. Industrial visit to study material handling practices and its report

Reference Books:

1. Material Handling - Immer J. R. (McGraw Hill)
2. Plant Layout & Material Handling - James Apple (John Wiley)
3. Material Handling System Design - James Apple ((John Wiley)
4. Material Handling Principles & Practice - Theodore H. Allegre Sr. (CBS Publishers & Distributors)
5. Facilities Planning – 3/e, Tompkins, White, Bozer, Tanchoco (John Wiley & Sons)
6. Material Handling Handbooks
7. Work Study - O. P. Khanna (Dhanpatrai & Sons)

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Elective-II: 5. ARTIFICIAL INTELLIGENECE

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Corse Objective:

To understand the fundamental concepts of Artificial Intelligence and its applications.

Course Outcome:
The students shall demonstrate the knowledge of the fundamental concepts of Artificial Intelligence and its applications.

Unit-1
Introduction: Concept of AI, approaches – acting and thinking like humans and rationally, brief history of A.I, foundations of A.I, underlying assumptions, application areas. (3)
Problem formulation: Problem solving agents, components of problem definition, defining the problem as state space approach, Problem characteristics, Production system, searching for solutions ,Forward & Backward reasoning, means end analysis, Graphs and Trees, measuring problem solving performance. (4)

Unit - 2
Search Strategies: a) Uninformed (blind) search – breadth first, depth first and their variations, avoiding repeated states b) Informed (Heuristic) Search – evaluation /heuristic function, generate and Test, Best first search, A* search, Local search algorithms – Hill climbing, simulated annealing, local beam search, Branch & Bound search, Genetic Algorithms, terminology. (5)

Unit - 3
Knowledge Representation: Simple relational knowledge, Inheritable knowledge, Inferential knowledge, Procedural knowledge, the frame problem, Propositional Logic–Syntax and semantics, properties of statements, Inference rules, First Order Predicate Logic: syntax and semantics, well formed formulas (WFF), Properties of WFFs, conversion to clausal form, using FOPL, inference rules, unification, non-deductive inference methods, resolution, forward and backward chaining, the knowledge engineering process. Handling uncertain knowledge, probability propositions, atomic events, unconditional (prior) and conditional (posterior) priority, Bayes' rules and its use, Bayesian network and its semantics, inference in Bayesian networks. (7)

Unit - 4
Learning: Forms of learning, inductive learning, decision trees learning, ensemble learning, pattern recognition: introduction, recognition and classification process, learning classification patterns. (4)
Knowledge Based Systems: Expert systems, components, characteristic features of expert systems, applications, rule based system architecture, representing and using domain knowledge, expert system shell, explaining the reasoning and knowledge acquisition, applications. (6)

Unit - 5
A.I. in Robotics: State space search, Block word and robot example, path selection, Monkey and Banana problem, AND – OR graph, means end analysis in a robotic problem, robot problem solving as a production system, triangle table, robot learning, robot task planning, phases in task planning, symbolic spatial relationships, obstacle avoidance, graph planning. (6)

Unit - 6
Machine Vision: Introduction, functions in a vision system, imaging devices, lighting, A-D conversion, quantization, encoding image storage, image data reduction, segmentation techniques, feature extraction, object recognition, training the vision system, robotic applications of machine vision. (5)

Term Work:
The term work shall consist of the following.
1. Minimum Six programming exercises using a suitable language (e.g. PROLOG, LISP, C++ etc.) preferably in manufacturing related area.
2. One case study on application of A.I. & E.S. in Manufacturing Engineering /Management.

Reference Books:

1. Artificial Intelligence: A Modern Approach- 2 /e (2003) Stuart Russel, Peter Norvig (Pearson Education).
2. Artificial Intelligence: 2/e (1991)- Elaine Rich, Kevin Knight (TMH).
3. Introduction to Artificial Intelligence & Expert Systems – Dan W. Patterson. (Seventh Indian Reprint 1999) (EEE) (PHI).
4. Handbook of Expert Systems in Manufacturing – Rex Mauss, Jessica Keyes (Mc Graw Hill).
5. Industrial Robotics – Technology, Programming and Applications - Groover, Weiss, Nagel, Odrey, (Mc Graw Hill).
6. Robotics: Control, Sensing, Vision and Intelligence – Fu, Gonzalez and Lee. (McGraw Hill).
7. Conference Proceedings & Current Journals for case studies and applications.

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Elective-II: 6. INDUSTRIAL ROBOTICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective:
To study fundamentals, analysis, applications and programming for industrial robots.

Course Outcome:
The students shall have the knowledge of fundamentals, analysis, applications and programming of industrial robots.

Unit-1
Introduction: Automation and Robotic System, Anatomy and work volumes, Classification. **Drives & Control System:** Hydraulics and pneumatic actuators, electrical drives for robotics, control loops, basic control system concepts and models, control system analysis, robot activation & feedback components, position and velocity sensors, power transmission system. (6)

Unit-2
a) Robot & Peripherals: End effecters – types, mechanical electromagnetic, pneumatic grippers, tool as end effecter, robot end effecter interface. Sensors – sensors in robotics, tactile sensors, proximity and range sensors, sensor based systems and uses.
b) Machine Vision- Introduction, low level and high level vision, sensing and digitizing, image processing and analysis, segmentation, edge detection, object description and recognition, interpretation, applications. (8)

Unit-3
Programming for Robots: Methods, robot program as a path in space, motion interpolation, characteristics of robot level and task level languages, robot languages, programming in suitable languages, Simulation of robot programs. (6)

Unit-4
Robot Kinematics: Introduction, forward, reverse & homogeneous transformations, manipulator path control, introduction to robot dynamics configuration of a robot controller. (6)

Unit-5

Robot Intelligence and Task Planning: Introduction, state space search, problem reduction, use of predictive logic, means – ends analysis, problem solving, robot learning, robot task planning. (6)

Unit-6

Robotic Applications: Applications in manufacturing -material transfer, machine loading and unloading, processing operations, assembly and inspections, robotic cell design and control, applications in other areas: toxic, hazardous and inaccessible, service industry. **Social Issues-** safety and economics in robotics. (8)

Term Work:

Minimum Six exercises from following.

1) Two Programming exercises for robots.
2) Three case studies of applications in industry involving working out the scheme with type of
3) robots, other accessories with sequence and logic.
4) Three exercises using a suitable robotic simulation software for handling applications.

Reference Books:

1) Industrial Robotics: Technology, Programming & Applications- Groover, Weiss, Nagel, Ordey McGraw Hill
2) Robotics: Control, Sensing, Vision & Intelligence. - Fu, Gonzalez, Lee (McGraw Hill)
3) Robotics Technology & Flexible Automation – S.R. Deb (TMH)
4) Handbook of Industrial Robotics – Ed. Shimon Y. Nof (John Wiley.)
5) Fundamental of Robotics, Analysis & Control – Robert J. Schilling (PHI)
6) Robotics for Engineers – Yoram Koren (McGraw Hill)
7) Introduction to Robotics: Analysis, Systems & Applications – Saeed B. Niku (Pearson Education)
8) Keramas, James G. (1998), " Robot Technology Fundamentals", ISBN: 981-240-621-2 (CENGAGE)

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ELECTIVE-I1: 7. COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective:

To understand the concepts of computer integrated manufacturing system and its applications.

Course Outcome:

The student shall demonstrate the knowledge of the concepts of computer integrated manufacturing system and its applications.

Unit-1

Basic Concept of CIMS,:-Scope, islands of automation, architecture of CIM, information flow in CIM, elements of CIM, benefits, limitations, obstacles in implementation Planning for CIMS, need for planning, Phases of CIM implementation, incremental implementation and one time implementation,

CIM benchmarking, Economic and social justification of CIM. (6)

Unit-2

Product Design and CAD, application of computers in design, CAM – manufacturing planning and control, scope of CAD / CAM and CIM, Concurrent engineering, Design for manufacturing and assembly ,Case studies on Concurrent engineering, Design for manufacturing and assembly. (6)

Unit-3

a) Group Technology: Concept, design and manufacturing attributes, part families, composite part, methods of grouping, PFA, classification and coding system- OPITZ, Relevance of GT in CIM, GT and CAD, benefits and limitations of GT. (3)

b) Computer Aided Process Planning and Control: need, retrieval and generative type CAPP, role of CAPP in CIM. (2)

c) Computer Aided Production Planning and Control: Computer integrated production management system, Role of computers in aggregate planning, master production schedule, shop floor control, materials requirement planning, and capacity planning, manufacturing resource planning and enterprise resource planning (3)

Unit-4

Flexible Manufacturing Systems, Transfer lines, Assembly Lines in CIMS: Concept, flexible & rigid manufacturing, manufacturing cell and FMS structure, types, components of FMS, Distributed Numerical Control (DNC), Building Blocks of FMS, Flexible Assembly System, Transfer Lines, concept, applications, benefits, Automates assembly lines, Design for assembly. (6)

Unit-5

Production Support Machines and Systems in CIM: Robots, types, joint configurations, Industrial robots for load/unload, automated material handling, automatic guided vehicles, Types, Vehicle guidance, Management and safety, automated storage and retrieval system. (6)

Unit-6

a) Data Acquisition and Database Management Systems: (a) Data acquisition system, type of data, automatic data identification methods, bar code technology, machine vision.(b) Data and database management system, database design requirements, types of DBMS models- hierarchical, network and relational models and their applications (4)

b) Communication in CIMS: Role of communication in CIMS, requirements of shop floor communication, types and components of communication systems in CIM, Networking concepts, network topology, access methods, ISO-OSI reference model for protocols, MAP/TOP, TCP/IP. (4)

Term work:

1) Exercise on classification and coding of components using GT Techniques, related toa) Design Attributes, b) Manufacturing attributes.
2) Exercise on building MRP system for a company manufacturing approximately 3 – 5assembly products involving total about 15 components.
3) Exercise on capacity planning for a turning shop with 5 – 10 lathes, 15 turnedcomponents with average 3 to 4 turning operations each, for given batch sizes.
4) Study of co-ordinate measuring machine involving study of dimensions andgeometrical features of components, accessories of C.M.M.s and programming aspects,through an industrial visit and its report
5) Exercise on Database Management- Creation of a simple manufacturing database usingMS Access or similar software involving query, sorting.
6) Case study on data acquisition systems, LAN structure & communication interface.

Reference Books:

1) Automation, Production systems and Computer Integrated Manufacturing, 3/e - M.PGroover (PHI or Pearson Education)
2) Computer Integrated Design and Manufacturing - Bedworth, Henderson & Wolfe,(McGraw Hill)
3) Performance Modeling of Automated Manufacturing Systems, 2/e - Viswanadham, N&Narahari, Y. (EEE) (PHI)
4) Principles of Computer Integrated Manufacturing - S. Kant Vajpayee, (PHI)
5) CAD / CAM Principles and Applications - P.N. Rao (Tata McGraw Hill)
6) CIM Handbook - Teicholtz& Orr (McGraw Hill)
7) CAD/CAM/CIM, 3/e – Radhakrishnan, Subramanayam&Raju (New Age International)
8) Computer Integrated Manufacturing, 2/e - James A. Rehg, H. W. Kraebber, (PearsonEducation)
9) MAP/TOP Networking : Foundation of CIM – Vincent Jones (McGraw Hill)

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Elective-III: 1. MARKETING MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hr. / Week/ Batch	Term work: 25 Marks

Course Objective:
Study of fundamentals of marketing and its commercial and technical application.

Corse Outcomes:
The students shall be able to demonstrate the knowledge of fundamentals of marketing and its commercial and technical application

Unit-1
Introduction: Meaning, scope, needs and importance of marketing, difference between marketing and selling, concept of market, types of markets, marketing concepts and tools, concept of societal marketing, marketing strategies, impact of Multi National Corporations, privatization etc. Ecommerce/ On line marketing. (5)

Unit-2
Buying Behavior of Organizational and Consumer Buyers: Factors influencing buying process analysis of behavior. (3)

Marketing Planning: Meaning and importance, marketing strategies, sales forecasting, methods of sales forecasting, marketing budget and marketing organization, data banks utilization (3)
Market Segmentation: Meaning, bases for segmenting consumer markets, market coverage strategies adopted for segmenting the market, aggregation strategy, single segment strategy and multiple segment strategy. (3)

Unit-3
Marketing Information systems [MIS]: Marketing research marketing research procedure, the order – shipping - billing cycle, the system of sales reporting, computer integration. (5)

Unit-4

I) Marketing Mix: Introduction to marketing Mix elements - product, place, promotion and rice

a] Product [Goods and Services]: Concept of product, classification of consumer goods, convenience goods, shopping goods and specialty goods, product life cycle, product mix, product decisions to be made such as brand policy decisions, product modification decisions, product elimination decisions, new product development decisions and product mix decisions, procedure for new product development.

b] Place: Channels of distribution, meaning, types of channels, selecting the type of a channel, channel management, physical distribution wholesaling and retailing.

c] Promotion: An introduction to promotion-mix elements, advertising, personal selling, sales promotion and publicity

d] Pricing: Meaning and importance of price, pricing objectives, procedure for setting the base price, price modification and price negotiation (8)

II) Advertising: Objectives, types of advertisements, developing advertising campaign, deciding on advertising media, sales promotion and publicity, ethics, regulations for advertising. (2)

Unit-5

Sales Management: Meaning and its role in marketing function responsibilities of sales department, personal selling, sales force, designing a sales force, recruiting and selecting a sales force, training and remuneration of sales force, sales territories, sales quotas, performance evaluation of sales staff, salesmanship (4)

Ubit-6

Industrial Marketing: MNCs, other major participants, cultural environment, attitudes, practices, ethics, monetary system; Export marketing – need, information, database and legislation (3)

Term Work:

Any five exercises to be conducted based on topics below (Sr. No. 6 compulsory).

1. Survey of Buyers.
    - Questionnaire Preparation – product / service
    - Obtaining the feedback
    - Analysis
2. Case study based on selection of product / service and its technical study from various competitors available nearby.
3. Development of market segmentation strategy for a product of a company.
4. New product development based on survey of 10-15 potential buyers.
5. Case study based on (any one)
    - Distribution network of a company
    - Developing an Advertising campaign for a product.
6. Group discussion on any one of the above topic (each group of about 8 students).

Reference Books:

1. Kotler, Armstrong, “Principles of Marketing”, 10/e, Pearson Education
2. Philip Kotler, “Marketing Management”, Prentice-Hall of India.
3. J.C.Gandhi, “Marketing- A Managerial Introduction”, TMH
4. David Luck et al, “Marketing Research”, TMH
5. Mahendra Mohan, “Advertising Management” TMH.
6. James S. Norris, “Advertising”, Prentice-Hall of India.
7. B. Horvard Levy, “ Marketing made simple”, Rupa Paperback on Business Management
8. J.C.Gandhi, “ Principles of Marketing and Salesmanship”
9. Hill,“ Industrial Marketing”

10. S.A.Sherlekar,"Marketing Management"
11. Ramswami and Namkumari, "Marketing Management"
12. Stanton, Etzel, Walker, "Fundamentals of Marketing", McGraw Hill
13. P. J. Joshef, "E – Commerce", PHI

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Elective-III: 2. STATISTICS FOR ENGINEERING RESEARCH

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hrs. / Week/ Batch

Examination scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objective :
To study the fundamental concepts and methodology of statistics with reference to its application in engineering research.

Course Outcome :
The students shall have the knowledge of fundamental concepts and methodology of statistics with reference to its application in engineering research.

Unit-1
Research Methodology: Introduction. The Design of Research, Meaning, Need, Dimensions and Process, Types of research design, Hypothesis Testing: Sampling theory; Formulation of Hypotheses, Sampling Techniques- Simple random sampling, systematic, Stratified, Multistage, Cluster sampling, Designing and Methodology of an experiment. Introduction: Measures of Location: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Mode and simple properties. Measures of Dispersion-Range, Quartile Deviation, Mean Deviation, Variance, Standard Deviation, Coefficient of Variation. (6)

Unit-2
Probability: Statistical Probability with simple problems. Conditional probability. Baye's Theorem. (5)

Unit-3
Test of Significance: Sampling distribution of mean and standard error, Large sample tests- Z- Test for an assumed mean and equality of two population means, Small sample tests, t-test for an assumed mean and equality of means of two populations, Paired t-test. Confidence Interval for means. (8)

Unit-4
Correlation and Regression: Bi-variate data, Simple correlation and Regression coefficients and their relation. Linear regression and equations of line of regression. Curve Fitting. (5)

Unit-5
Test using Chi-square Distribution: Inference about population variance (F test). Goodness of fit test. Test for independence of attributes Yates's Correction. Confidence Interval for variances. (5)

Unit-6

Experimental Design: Principles of experimental designs, completely randomized design. Randomized block design and precision of results. Simple factorial Experiments of 2^2, 2^3. Analysis of variance (ANOVA) and its uses in the designs. (8)

Term Work:

Total Six assignments based on each of the six units of the above syllabus, including quantitative assignments on data analysis, hypothesis testing, and analysis of variance using suitable statistical analysis software.

Reference Books:

1) Fundamentals of Mathematical Statistics - Gupta V.K. & Kapoor S.C..- S. Chand Publicatons.
2) Design and Analysis of Experiments, Montgomery, D.C.: Wiley Eastern Ltd., New Delhi.
3) Statistical Methods, S P Gupta, Sultan Chand & Sons, Latest edn
4) Statistics for Management- T. N. Srivastava, Sailaja Rego, Tata McGraw Hill Publications.
5) Fundamentals of Business Statistics, 2nd Edition, J. K. Sharma, Vikas Publication, 2014.
6) Research Methodology- Methods and Techniques, Kothari, C.K., (2004), 2/e, (New Age International, New Delhi)
7) Research Methodology, Panneerselvam, PHI, ISBN: 81-203-2452-8

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Elective-III: 3. MATERIALS MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hrs. / Week/ Batch	Term work: 25 Marks

Course Objective:

Study of fundamental concepts and applications of various techniques of Materials Management in practice.

Course Outcomes:

The students shall have the knowledge of various concepts and application of different techniques of materials management.

Unit-1

Introduction: integrated materials management concept. Objectives, organizational structure, material cycle, Make or Buy Decision- factors, financial and manufacturing aspects (4)

Unit-2

Materials Forecasting: general economic forecast, major cyclical indicators, forecasting the price, materials requirement planning.(MRP) Purchasing- Functions, Procedures, Documents used as per ISO 9001, Policies, Types of purchasing - hand to mouth, forward buying, speculative buying, commodity markets, price -cost analysis, negotiations (8)

Unit-3
Selection of sources of supply, Vendor evaluation and rating, Vendor development. Purchase research**,** value analysis, introduction to legal aspects of purchasing. (7)

Unit-4
Inventory Management: Basic concepts, Need, Deterministic and Probabilistic EOQ models, Inventory costs, Selective Inventory control techniques- ABC and VED analysis, Fixed quantity, Periodic review system, Spare Parts Inventory Management, safety stock determination (7)

Unit-5
Stores Management: Objectives, stores layout, storage system and equipment, automated storage and retrieval system, Procedures & Documents as per ISO9001, material classification and codification as per ISO 9001, materials accounting system. (6)

Unit-6
Recent Trends In Inventory Management: Zero inventory, JIT concept and tools, Management performance evaluation, information systems and computers applications in materials management, ERP module of MM. (4)

Term Work:
The term work shall consist of any Six assignments based on following topics.
(At least one exercise based on computers)
1. Case study on Make or Buy decision
2. Study of Material cycle, documents as per ISO / QS 9000.
3. Case study on Vendor Rating
4. Case study on fixed period orders and fixed quantity inventory system with safety stock analysis
5. Exercise on MRP for a system with 2 to 3 product assemblies, each having about five components
6. Exercises on probabilistic EOQ models
7. Study of materials classification and codification

Reference Books:
1. Materials Management - Dean S. Ammer (Taraporwalla & Sons)
2. Purchasing Management- J.H. Westing, I.V. Fine C.J. Zenc (John Wiley and Sons)
3. Purchasing & Materials Management - Lamer Lee Jr... Donad W. Dobler (TMH)
4. Integrated Materials Management- A. K. Dutta (S. Chand & Co.)
5. Stores House and Stock management - H. K. Comption (Business Books Ltd.)
6. Storage Controls & Stocks - Alex Morrison (ELBS)
7. Purchasing and Materials Management- P. Gopalkrishnan (TMH)
8. Materials Management - A. K. Dutta (PHI)
9. Stores Management – K.S.Menon (MACMILLAN)

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Elective-III: 4. PROJECT MANAGEMENT

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Corse Objective:
To study the fundamental concepts, tools and techniques of Project Management & its applications.

Course Outcome:
The students shall demonstrate the knowledge of the fundamental concepts, tools and techniques of Project Management & its applications.

Unit-1
Introduction to Project:
Definition of a Project, Types, Sequence of Activities, Unique activities, Complex Activities, Connected Activities, One Goal, Specified Time, Within Budget, According to Specification. Defining a Program, Project parameters: Scope, Quality, Cost, Time, Resources; The scope triangle: Time, Cost, and Resource Availability, Project Classification. (3)

Unit -2
Project Management:
Principles of Project Management: Defining, Planning, Executing, Controlling, Closing; Project Management Life Cycle: Phases of Project Management, Levels of Project Management; Quality Management: Continuous Quality Management Model, Process Quality Management Model; Risk Management, Risk Analysis; Relationship between Project Management and other Methodologies. (6)

Unit-3
Project Activities:
Work Breakdown Structure, Uses of WBS, Generating the WBS: Top-Down/ Bottom-Up Approach, WBS for Small Projects, Intermediate WBS for large projects; Criteria to Test for Completeness in the WBS: Measurable Status, Bounded, Deliverable, Cost/Time Estimate, Acceptable Duration Limits, Activity Independence; Approaches to Building the WBS: various approaches, Representing WBS. **Activity Duration, Resource Requirements, & Cost:** Duration: Resource Loading versus Activity Duration, Variation in Activity Duration, Methods for Estimating Activity Duration, Estimation Precision; Resources; Estimating Cost, JPP Session to Estimate Activity Duration & Resource Requirements, Determining Resource Requirements. (8)

Unit-4
Fundamentals of Project Network Diagram:
Project Network Diagram, Benefits to Network- Based Scheduling, Building the Network Diagram Using the PDM, Analyzing the Initial Project Network Diagram.

Network Analysis – PERT:
Introduction to Project Evaluation and Review Technique, Event, Activity, Dummy, Network rules, Graphical guidelines for network, Common partial situations in network, numbering the events, Cycles; Developing the Network, Planning for network construction, modes of network construction, steps in developing network, hierarchies; Time Estimates in PERT, Uncertainties and use of PERT, Time estimates, Frequency distribution, Mean, Variance & standard deviation, Probability distribution, Beta distribution, Expected time; Time Computations in PERT, Earliest expected time, Formulation for TE,

Latest allowable occurrence time, Formulation for TL, Combined tabular computations for TE, TL; Slack, Critical Path, Probability of meeting schedule date. (9)

Unit-5

Network Analysis- CPM:

Introduction to Critical Path Method, Procedure, Networks, Activity time estimate, Earliest event time, Latest allowable occurrence time, Combined tabular computations for TE and TL, Start & Finish times of activity, Float, Critical activities & Critical path. Crashing of project network, Resource leveling and Resource allocation. (8)

Unit-6

Schedules Based on Resource Availability:

Resources, Leveling Resources, Acceptability Leveled Schedule, Resource Leveling Strategies, Work Packages: Purpose of a Work Package, Format of a Work Package. (6)

Term Work:

Term work shall consist of at least six assignments based on above units. At least one assignment shall be based on computer application for project management using suitable software.

References Books:

1) Prasanna Chandra, "Projects – Planning, Analysis, Financing, Implementation and Review", Tata McGraw Hill,4th Ed, 1997
2) Mike Field and Laurie Keller, "Project Management", Thompson Business press, 2002
3) Gido and Clements, "Successful project management", 2nd edition; Thompson south-western, 2003
4) John M Nicholas, "Project Management for business and technology", 2nd edition, Pearson Education Asia, 2001
5) Bhavesh M Patel, "Project Management – Strategic Financial planning, Evaluation and control", Vikas publishing house, 2000
6) S.Choudry "Project Management", Tata McGraw Hill,27th edition, 2006
7) Effective Project Management Robert K. Wysocki, Robert Beck. Jr., and David B. Crane; - John Wiley & Sons.
8) Project Planning and Control with CPM and PERT- Dr. B.C. Punamia & K.K.Khandelwal; - Laxmi Publications, New Delhi.
9) Project Management- S. Choudhury, - TMH Publishing Co. Ltd, New Delhi
10) Total Project Management- The Indian Context- P. K. Joy, - Macmillan India Ltd., Delhi
11) Project Management in Manufacturing and High Technology Operations- Adedeji Bodunde Badiru, - John Wiley and Sons.
12) Course in PERT & CPM- R.C.Gupta, - DhanpatRai and Sons, New Delhi
13) Fundamentals of PERT/ CPM and Project Management- S.K. Bhattacharjee; - Khanna Publishers, New Delhi

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Elective-III: 5. FINANCIAL MANAGEMENT

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme:
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objective:
To study the basic concepts of financial management applied to manufacturing industry.

Course Outcome:
The students shall be able to demonstrate the knowledge of financial management as applied in the manufacturing industry.

Unit-1
Finance Function and Sources of Finance: - Objectives of Financial management, finance Functions, Internal and External, Short, medium, and long term finance (6)

Unit-2
Management Accounting: Types of financial statements, Interpretation of financial statements using Ratio Analysis, cost volume profit analysis, Working capital management. (8)

Unit-3
Financial structure, cost and financing decisions: - Planning capital structure, Debt – Equity Ratio and financing, cost of capital, concept of operating and financial leverage, capital budgeting – Nature and significance .Techniques of capital budgeting. (6)

Unit-4
Project Planning: - Generation and screening of project ideas market and demand analysis, technical analysis financial estimates and projection. (4)

Unit-5
Marketing of Securities and Dividend Policies: - Underwriting, role of stock exchange, functions, operations, government regulations of stock exchanges in India, Issue of bonus shares, Right issue, Dividend policies, determinants of dividend policies, concept of portfolio analysis. (8)

Unit-6
Budgeting and budgetary control: Meaning of budget, budgetary control, budgeting, essentials of effective budgeting, advantages and limitations, classification, flexible budget, cash budget, sales budget. (8)

Note: - Numerical Treatment is expected for the following topics:
1. Ratio Analysis.
2. Cost volume profit analysis
3. Capital Budgeting
4. Cost of Capital
5. Working Capital
6. Budgeting: a) Flexible Budgeting b) Cash Budget c) Sales Budget

Term Work:
1. One assignment on Finance Function to be studied by visiting a local industrial organization.
2. Numerical exercises on the areas mentioned above
3. Two case studies on industrial financing

Reference Books:
1. Financial Management- I.M Pandey. Vikas Publishing House Pvt Ltd.
2. Management Accounting & Financial Management – R.K.Sharma & Shashi K. Gupta–Kalyani Publishers.
3. Project Planning, Analysis, Selection, Implementation & Review. - Prasanna Chandra-Tata Mac

Grew Hill Publishers.
4. Financial Management- P.V. Konkani &B.G Sashay Prasad – Himalaya Publishing House.
5. Management Accounting- R S.N Pillai, Bagavathi – S.Chand & Company Ltd.
6. Corporate Finance – S. C. Kuchhal & Suchitra Mittal (Chaitanya Publication House)
7. Financial, Cost and Management Accounting – Dr. P. Periasamy, Himalaya Publishing House.
8. Financial Management – Dr. P. Periasamy, Himalaya TMH.

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B. E. (Production Engineering) Part- II, Semester VIII

Elective-III: 6. ENTREPRENEURSHIP DEVELOPMENT

Teaching Scheme:
Lectures: 3 Hrs. / Week
Practical: 2 Hr. / Week/ Batch

Examination Scheme :
Theory Paper (3 Hrs): 100 Marks
Term work: 25 Marks

Course Objective:
To familiarize students with fundamentals of Entrepreneurship and to encourage them to become successful entrepreneurs.

Course Outcomes:
The students shall demonstrate the knowledge of Entrepreneurship and shall be motivated to become successful entrepreneurs.

Unit - 1
Entrepreneurship: Definition of Entrepreneur and Entrepreneurship, entrepreneurial process, Entrepreneurship and economic development, job creation, Indian scene.
Entrepreneurial Motivation: Self-disclosure, personality effectiveness, risk taking, entrepreneurial competencies, case studies. (3)

Unit - 2
Small Scale Units: Concept and definition, role of S.S.I. in Indian economy, government policies and facilities.
Planning Small Scale Business: Business opportunity identification, idea generation, ideas from marketplace, market assessment, demand estimation.
Small Business Management: Techniques of marketing, materials, production, manpower and financial management, crisis management, working capital management, fixed capital assessment, cash flow analysis, ROI, techniques of decision making.
Demand Analysis: Demand Theory and Analysis – Individual demand and Market demand – Factors determining demand – Elasticity of demand – Price Elasticity - Income Elasticity – Cross Elasticity – Elasticity and Decision – making (Analytical problems). Demand estimation: Linear regression, Interpreting coefficients, Interpreting regression fit, Omitted variables, Log linear estimation. Consumers Equilibrium, Cardinal utility approach, Indifference curve approach, Theory of revealed preference, Consumer surplus (8)

Unit - 3
Managerial Economics: Introduction to Economics, Kinds of Economic Decisions, Significance and applicability of Managerial Economics in decision making, Role and responsibilities of Managerial Economics, Economic principles relevant to managerial decision making, Opportunity cost, Production

possibility curve, Concept of increments and Margin, Discounting principle. (Numerical Problems)

Business Accounting: Study of Balance sheets, Profit and Loss statements. Need, format of Trading and Profit and Loss A/c., Items to be recorded on the Debit and Credit Side of Trading and Profit and Loss A/c, Preparation of Trading and Profit and Loss A/c. Need, format of Balance Sheet, identification of Accounts to be written on liabilities and Assets side, Preparation of Balance sheet. (Analytical Problems) (9)

Unit – 4

Government Support Organizations:

The detailed study of the government support system for the entrepreneurship development.

a) Central Government
b) State government
c) Financial support organizations
d) Government schemes and procedures (6)

Unit - 5

Business plan preparation: Meaning of business plan, project parameters, information sources of economical and technical knowhow, selection of location, identification of raw material, suppliers, plants/machinery, process, manpower and other inputs such as power, water etc. Preparation of project report including the following aspects. Analytical calculations for decision making at each of the following shall be included.-

1) Selection of product.
2) Process and plant and machinery selection.
3) Site selection and Plant Layout planning.
4) Financial viability analysis.
5) Marketing and distribution of goods.
6) Study of probable reasons of failure. (8)

Unit - 6

Statutory Requirements: Factories Act 1948, Industrial disputes Act 1947, Indian Contract Act, Indian sales and Goods Act, Indian Partnership Act, Central Excise, Sales tax, Income Tax Act, Value Added Tax (VAT).

Business Aspects: Business ethics, export environment, procedure and documentation, venture capital financing, intellectual property act, patents, GATT. (6)

Term Work:

Minimum Six exercises / case studies based on the topics below. Assignment No. 2, 4 & 6 shall include the analytical problems.

1. Study of Government policies and procedures to start SSI.
2. Study of Calculations of working capital requirements.
3. Study of resources and procedures to get financial assistance.
4. Study of tax procedures.
5. Study of export procedures.
6. Study & Preparation of project feasibility report for the manufacturing of a product.

Reference Books:

1. Developing New Entrepreneurs - Entrepreneurship Development Institute of India, Ahmedabad.
2. Handbook of New Entrepreneurs
3. Management of Small Scale Industry - Vasant Desai (Himalaya Publication)
4. Entrepreneurship Playing to Win- Gordon Betty (Taraporwala & Co.)

5. Motivating Economic Achievement- David C. McClelland, David G. Winter
6. Industrial Maharashtra- Facts, Figures and Opportunities (M.I.D.C. Mumbai).
7. Project Planning & Entrepreneurship Development - T. R. Banga
8. Dynamics of Entrepreneurial Development & Management- Vasant Desai (Himalaya Publication)
9. S.S.I. and Entrepreneurship- Vasant Desai (Himalaya Publication)
10. Petersen and Lewis : Managerial Economics, 4/e, Pearson/PHI, 2002. 2. Managerial Economics, Ahuja. H.L, S. Chand, New Delhi.
11. M.L. Trivedi: Managerial Economics, Tata Mc-Graw Hill, New Delhi 2004.
12. PindyckRubinfeld& Mehta, "Micro Economics", Pearson
13. Ramachandran, and Kakani, "How to Analyze Financial Statements", Tata McGraw Hill
14. Palat, Raghu, "How to Read Annual Reports and Balance Sheets", JAICO Publishing House
15. Dash A.P., "Financial Wisdom – Finance for Non-Finance Executives", Biztantra ISBN 978-81-7722-378-1

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Elective-III: 7. SUPPLY CHAIN MANAGEMENT

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs. / Week	Theory Paper (3 Hrs): 100 Marks
Practical: 2 Hrs. / Week/ Batch	Term work: 25 Marks

Course Objective:
To study the fundamentals and applications of various techniques of Supply Chain Management in practice.

Course Outcome:
The students shall have the knowledge of the fundamentals and applications of various techniques of Supply Chain Management in practice.

Unit-1:
Introduction to Supply Chain Management: Building a Strategic framework to Analyze Supply Chains: Understanding the supply chain, supply chain performance, Supply chain drivers & obstacles.(5)

Unit-2:
Planning Demand & Supply in Supply Chains: Demand forecasting in supply chain, aggregate planning in supply chain, planning demand & supply in supply chains. (6)

Unit-3:
Planning & Managing Inventories in a Supply in Supply chains: Managing economies of scale in a supply chain: cycle inventory, managing uncertainty in supply chain: safety inventory, determining optimal level of product availability. (6)

Unit-4:

Design consideration in Supply Chain: Transportation, Network Design, & Information technology in a supply chain: Transportation in supply chain, facility decisions: network design in a supply chain, information technology in a supply chain. (7)

Unit-5:

Supply Chain Coordination Logistics in SCM: Coordinating in a Supply Chain & role of E-Business: Coordination in a supply chain, E- business & the supply chain.

Logistics In Supply Chain Management: Introduction, Strategy, Transportation Selection, Trade-off, Models for Transportation and Distribution, Third Party Logistics,, Overview of Indian Infrastructure for Transportation. (7)

Unit-6:

Financial consideration in Supply Chain: Financial factors Influencing Supply Chain Decisions: Financial evaluation of supply chain decisions, the impact of financial factors on supply chain decisions, evaluating supply chain decisions using decision trees, (6)

Term Work:

Any six assignments based on the above syllabus (One from each unit)

Text Books:

1. Sunil Chopra & Peter Meindl, "Supply Chain Management: Strategy, Planning, & Operation", Addison Wesley Long man.
2. A. J. Vanweela, "Purchasing & Supply Chain Management"Cengage learning(Nov2004) ISBN 1844800245

Reference Books:

1. R.H. Ballou, "Supply Chain Management" Pearson[2007] ISBN 8131705846 B. E. Production Engineering – S / W - 2008 Proposed Syllabus Page 36 of 42
2. Simchi-Levi, Kaminsky, "Designing and Managing the Supply Chain, Concepts Strategies and Case Studies", 2nd edition, Tata McGraw Hill, ISBN 0-07-058666-7
3. R. Monczka, "Purchasing & Supply Chain Management" Cengage learning business Press.,ISBN 140801744X

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6. PROJECT WORK- Phase II

Teaching Scheme:
Practical: 4 Hrs. / Week/ Batch

Examination Scheme:
Term work: 75 Marks
Oral Examination: 50 Marks

Course Objective:

To prepare the students to carry out a comprehensive study of any design or process or phenomenon, to encourage the process of independent creative thinking and working in groups and to expose them to industrial atmosphere of accountability.

Course Outcomes:
The students shall have the ability to carry out a comprehensive study of any design or process or phenomenon as well as independent creative thinking and working in groups with exposure to industrial atmosphere of accountability.

Term Work:
The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The work started in Semester VII will be continued in the Semester VIII and the final submission of the report will be at the end of the Semester VIII.

The project work may consist of-
1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Design of any equipment and / or its fabrication and testing.
3. Critical Analysis of any design or process for optimizing it.
4. Experimental verification of principles used in applications related to Production or Mechanical Engineering.
5. A combination of the above.

A synopsis of the selected project work (two to three pages typed on A4 size sheets) will be submitted and assessed by the Project Guide and one more faculty member appointed by the Department / concerned responsible official of the sponsoring industry (Co-guide).

The work to be completed in Semester VII shall include-
a) Problem Identification
b) Methodology / Design Documents
c) Activity planning for the time frame and **division of responsibility to each student**. An interim report of the work completed in Semester VII in the form of workbook /project diary and other relevant documents shall be submitted for the term work. The term work shall be assessed by the Guide and one more faculty member appointed by the Head of the Department. The assessment shall be based on a presentation of the work completed and submission of interim report.
The oral examination shall be based on the work planned and actually completed in Semester-VII.