UNIVERSITY OF MUMBAI

No. UG/264 of 2009

RG/327 (7)

RCULAR :-

A reference is invited to the Ordinances, Regulations and syllabi relating to the ...elo... of Engineering degree course **vide** this office Circular No. UG/461 of 2003, dat... 9th September, 2003 and the Principals of the affiliated collages in Engineering are ...ere... informed that the recommendation made by the Faculty of Technology at its meeting held on 1st April, 2009 has been accepted by the Academic Council at its meeting held on 27th May, 2009 **vide** item No. 4.26 and that, in accordance therewith, the syllabus for the Third Year Production Engineering (Sem. V and VI) of the B.E. degree course is revised as per **Appendix** and that the same has been brought into force with effect from the academic year 2009-2010.

PRIN. K. VENKATARAMANI
REGISTRAR

MUMBAI-400 032
7th July, 2009

To,

The Principals of the affiliated collages in Engineering .

AC/4.26/27/05/2009

****

No.UG/264- A of 2009, MUMBAI-400 032 7th July, 2009

Copy forwarded with compliments for information to :-

1. The Dean, Faculty of Technology,
2. The Chairman, Board of Studies in Mechanical Engineering .
3. The Controller of Examinations,
4. The Co-Ordinator, University Computerization Centre,

07/07/09

(D. H. KATE)
DEPUTY REGISTRAR
U.G./P.G. Section.

****

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Mi ...ation), the Director of Students Welfare, the Executive Secretary to the Vice-Chancellor, the Pro-Vice-Chancel... Registrar and the Assistant Registrar, Administrative sub-center, Ratnagiri, for information .

... Record Section (

Enclosure to Item No. 4.26
27.5.2009

UNIVERSITY OF MUMBAI

Revised Syllabus for the

Third Year Production Engineering

(Semester V & VI)

(With effect from the academic year 2009-2010)

SCHEME OF INSTRUCTIONS AND EXAMINATION (R-2007)

UNIVERSITY OF MUMBAI

COURSE: B.E. (PRODUCTION ENGINEERING)

YEAR: T.E., SEMESTER: V

Sr. No	Subjects	No. of periods of 1Hour			Duration of Theory Paper in Hours	Marks				
		Lecture	Practical	Tutorial		Theory Paper	Term Work	Practical	Oral	Total
1	Computer Aided Design & Finite Element Analysis	4	2	-	3	100	25	25	-	150
2	Metrology and Instrumentation	4	2	-	3	100	25	25	25	175
3	Design of Jigs and Fixture	4	2	-	4	100	25	-	25	150
4	Machining Science and Technology	4	2	-	4	100	25	-	25	150
5	Materials Technology	4	2	-	3	100	25	-	25	150
6	Environmental Studies*	2	--	1 #	2	50	25	--	--	75
TOTAL		22	10	1	-	550	150	50	100	850

classwise Tutorials

COURSE: B.E. (PRODUCTION ENGINEERING)

YEAR: T.E., SEMESTER: VI

Sr. No	Subjects	No. of periods of 1Hour			Duration of Theory Paper in Hours	Marks				
		Lecture	Practical	Tutorial		Theory Paper	Term Work	Practical	Oral	Total
1	Process Engineering and Tooling	4	2	-	4	100	25	-	25	150
2	Design of Press Tool and Metal Joining	4	2	-	4	100	25	-	25	150
3	Operations Research	4	2	-	3	100	25	-	-	125
4	Mould and Metal Forming Technology	4	2	-	4	100	25	-	25	150
5	Production & Operations Management	4	2	-	3	100	25	25	-	150
6	Machine Tool Design	4	2	-	3	100	25	-	-	125
TOTAL		24	12	-	-	600	150	25	75	850

SEMESTER V

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-V	
SUBJECT **Computer Aided Design and Finite Element Analysis**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	25
	Oral Examination	-	-
	Term Work	-	25
	Total	-	150

OBJECTIVE: To provide an introduction to the concepts of Computer aided design, Computer graphics and computer aided engineering (CAE) using FEM by which student gets a better perspective to use commercial software and hardware effectively. Scope is limited to elementary treatment of the topics.

Weightage:

Proportional to number hours indicated in the right column below.

Details of Syllabus:

Module No..	Details	Hrs
1 1.1	**Computer Aided Design:** **Introduction**: Need and Utility of CAD systems in Industry, Product Cycle, Definition of CAD tools based on their	2

1.2	Constituents and Implementation in a design environment. **CAD Hardware**: Types of systems, system considerations, I/O devices, Hardware integration & Networking.	
2. 2.1	**Computer Graphics**: Pixel plotting, Scan conversion of lines & circles; 2D & 3D transformations; 2D Viewing and Clipping; Parallel Projection. Elementary treatment of Hidden lines and Surfaces; Cubic spines Bezier curves& B-spines; Animation; Color models.	14
3 3.1 3.2	**Solid Modeling**, Types of representation of solid models, Interactive tools available with solid modeling software's. Introduction to surface modeling. **CAD Data Exchange**: File Structure and Format of IGES, STEP, DXF **Introduction to Rapid Prototyping**	08
4 4.1 4.2 4.2.1 4.2.2	<u>Finite Element method:</u> **Introduction:** General procedure of finite element method, Applications to Structural analysis and Manufacturing processes. **Static Analysis:** **Formulation**: Based on Principal of stationary total potential. **1-D FEA**: Generic form of FE equations for Linear & quadratic bar and Beam Elements **2-D FEA**: Dimensionality of a problem. Simple three noded triangular elements, four noded rectangular elements. Natural coordinates and coordinate transformation.2D element formulation for structural analysis to derive Stress- displacement and Stress strain matrix. Numerical integration by Gauss qudrature method. Meshing and compatibility of elements. Incorporation of boundary conditions and solution of static equilibrium equations.	18
5 5.1	**Introduction to Dynamic, Thermal analysis and computational Fluid Dynamics using FEM.** **Dynamic Analysis using FEM (No numerical)**	4

	Equations of motion and formulation of FE equations using 1D element for vibration problems. (Introductory)	
5.2	**Thermal Analysis using FEM (No numerical)** Basics steps for Thermal Analysis, Importance of Thermal analysis giving practical steady state conduction and convection examples. e.g. Pin fin, Expansion of railway track ,Flow through engine water jacket, Heat Exchanger etc.	
5.3	**Computational Fluid Dynamics using FEM(No Numerical)** The Navier – stokes equations ; The continuity equation and Law of conservation of mass and their application to CFD Typical Applications e.g. Aerospace Engineering ,Automobile Engineering	
6	**FEA software:** Features of commercial soft ware's: Preprocessor, solver and Postprocessor. Types of elements available with commercial software for different FEA applications (No Numerical).	02

TERM WORK:

1. Assignments on each topic.
2. 3-D modeling and Assembly. Using any suitable software
3. Simulation of Mechanism (Kinematics) using any suitable software
4. Static And dynamic analysis of structures.
5. One class test.

Text Books:

1. Mastering CAD/CAM by Ibrahim Zeid (Tata-Mcgraw-Hill)
2. Computer graphics by ISRD group (Tata-Mcgraw-Hill)
3. Finite element analysis by P.Seshu (Prentice Hall of India)

References:

1. CAD/CAM by P.N.Rao (Tata-Mcgraw-Hill)
2. Mathematical and Procedural Elements for computer graphics by Roger and Adams
3. Computer graphics by Hearn and Baker (PHI)
4. Computer graphics by Plastock and Gordon (Schaums outline series)
5. FEM by Fagan
6. FEM by J.N.Reddy(McGraw-Hill)
7. A first course in FEM by daryl.L.Logan (Cengage)
8. Concepts and applications of FEA by Cook, Malkus (Jhon-wiley)

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-V	
SUBJECT: **Metrology and Instrumentation**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	25
	Oral Examination	-	25
	Term Work	-	25
	Total	-	175

Objective :

Study of various Precision measuring methods relevant to manufacturing of Components and assemblies, study of some mechanical measurements such as force, torque and pressure.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Proportional to number hours indicated in the right column below.

Details of Syllabus:

Moduie No.	Details	Hrs

01	Introduction to metrology: Need for inspection, precision and accuracy; fundamental principles and definition , standards of measurement ; line, end and wave length standards, primary secondary and tertiary standards.	03
02	Limits, Fits and Tolerances : Requirement of interchangeable manufacture, allowance and tolerance, limits and fits, hole based and shaft based systems, IS 919 : 1963 tolerance grades IT 01 to IT 05, types of fits, general requirements of GO & NO GO gauging; Taylor's principle, Design of go & no-go gauges.	08
03	Comparators : Need for comparators, amplifying system ; mechanical, mechanical-optical, electrical, electronic and pneumatic comparators ; principle, construction and operation of various comparators, advantages; limitations and application of above comparators.	05
04	Interferometry : Principles of interference, monochromatic source, concept of flatness, flatness testing, optical flats, interference patterns and their significance, optical interferometer, laser interferometer. Surface Texture Measurement : Profile geometry, importance of surface condition, roughness and waviness, definition and significance of terms, band width selection, roughness standards specifying surface roughness parameters. Ra Ry Rz etc. RMS value, surface roughness measuring instruments such as Tomlinson surface meter. Taylor Hobson Talysurf, Measuring surface roughness, symbols ;	10
05	Measurement of Screw Threads : Types of screw threads, definitions, measurement of major and pitch diameters, two wire and three wire methods, floating carriage micrometer, and their applications. Measurement and Gauging of Gears : Types of gears, gear terminology and standard proportions : pitch circles diameter, circular pitch, diametral pitch and module, base pitch, addendum, dedundum, tooth thickness and width, base tangent method, gear tooth comparator, gear measurement using rollers, master gears and Parkinson tester.	14
06	Special Measuring Machines and Methods : Profile Projector, 3 D coordinate measuring machine, Tool Maker's Microscope. Mechanical Measurements and Instrumentation : Transducers (applications only) for measurement of displacement, velocity, acceleration, force, torque, temperature and fluid flow	08

Term Work:

1. At least one class test must be conducted in the middle of the semester & 10 marks weightage must be assigned during evaluation work.
2. At least six experiments based on the above syllabus and a report of laboratory work.
3. Design and drawing of following types of gauges :
   I. "Go" and "No GO" gauges for external dimensions.
   II. "Go" and "No GO" gauges for internal dimensions.

REFERENCES:

1. Metrology By Shotbolt
2. Practical Engineering Metrology By K.W.P.Sharp
3. Engineering Metrology By I.C.Gupta
4. Experimental Methods for Engineers By J.P.Holman
5. Instrumentation Devices and system By C.S.Rangan,G.R,Sarma, V.S.Mani.TMH
6. Industrial Instrumentation and Control By S.K.Singh TMH

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-V	
SUBJECT: **Design of Jigs and Fixture**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total	-	150

Objective:

Develop capability to design simple, productive and economic production toolings that are easy to manufacture, operate and maintain.

Approach:

Equal emphasis on concepts, procedures, practices and case studies.

Weightage:

Proportional to number hours indicated in the right column below.

Details of syllabus

Module No	Details	Hrs
01	Component Analysis Operation planning, sequencing of operations, locating faces, geometry , accuracy, material, machinability, quantity,	04

	modifications so as to assist production	
02	Design Analysis Selection of location and clamping faces/points, component distortion under clamping and cutting forces, compensation for component variation, choice of cutting tools and means of guiding and supporting Jigs and fixture details, jacks and supporting devices, drill and tool guide bushes , multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices. Mathematical derivations & Numerical on them for clamping elements	16
03	Types and construction of jigs and fixture Cast, fabricated and welded ; standard components and details, cost consideration with respect to quantity, quality and effectiveness, Economics & Costing of Jigs & Fixtures.	05
04	Jigs and fixture_ Principles of design and construction with reference to interchangeability ,simplicity, ease of operation, economy of motion, rigidity, durability, swarf disposal, study of typical examples and geometric location Design applications of typical jigs and fixtures_plate, channel, latch and box type drill jigs and jigs for drilling combined with reaming, tapping, counterboring and spot facing.	10
05	Milling fixtures including multistation and indexing types(for given component).Fixture for turning and grinding operations if needed balancing of the fixture also to be considered. Modular fixtures details and fixture design using computer software.	08
06	Case studies for practice for Jigs & Fixtures.	05

Term work:

1.At least three different designs and drawings based on the above syllabus.

2.Assembly drawings of a simple jig or fixture using computer software Autocad or any other CAD software.

3.At least one class test to be conducted at the middle of the semester for 10 marks.

The drawings for jigs and fixture should contain assembly and details; detailed drawings should contain all the tolerances and materials including heat treatment.

Text books:

1.Jig and Fixture Design Manual	by	Erik K. Henrikson, Industrial Press;1973.
2.An Introduction to Jig and tool Design	by	M.H.A. –Kempster, III Ed. Pub.ELBS 1985.
3.Jigs and Fixtures	by	P.H.Joshi ; TMH . 1988.
4.Tool Design	by	C. Donaldson, George H.Lecain.
		V.C.Goold; THM. 1980

Reference books:

1. Jigs and Fixture Handbook	by	A.K.Goroshkin, Mir Publication, 1988.
2. Jigs and Fixtures	by	ASTME
3. Non-Standards Clamping Devices	by	Hiram E. Grant.TMH. New Delhi. 1989.

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-V	
SUBJECT: **Machining Science And Technology**			
Periods per week 01 Period of 60 min	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total	-	150

Objective:

To impact knowledge and skill in the theory and practice of metal cutting and tool design..

Approach:

To enable the students to solve practical problems in the actual industrial situations.

Weightage:

Proportional to number hours indicated in the right column below.

Details of syllabus:

MODULE NO	Details	Hrs
01	Mechanics of metal cutting Various types of chips. Discontinuous	

continuous. With built up edge; shear plane and shear plane angle. Cutting ratio; orthogonal cutting and oblique cutting, Merchant's circle of forces and expression of shear stress and strain, normal forces on shear plane in terms of measurable cutting forces and shear plane angle, velocity relations.

$$\Phi = \frac{\Pi}{4} - \frac{(\lambda - \alpha)}{2}$$ Merchant's Theory

$$\Phi = C - \frac{(\lambda - \alpha)}{2}$$ Merchant's modified Theory

$$\Phi = \frac{\Pi}{4} - \lambda + \frac{\alpha}{2}$$ Earnst-Merchant equation

Cutting forces Gross power, net power in machining, efficiency of machine tools. Tangential cutting force; effect of speed, feed, depth of cut, tool material and angles, material variables on cutting forces; empirical formula for estimating cutting forces and power, concept of specific power consumption and metal removal factor.

Surface finish Height of feed ridges and built up edge as primary factors effecting surface finish; effect of speed, feed, depth of cut, tool material and angle, and material variables on surface finish.

Coolant Function of coolant, effects on cutting forces, tool life and surface finish, types of coolants, choice of coolants for various machining processes.

Materials for cutting tools Properties of cutting tool materials. Carbon tool steel; plain and alloyed, oil hardening, water hardening, properties, fields of application, limitations, high speed steel, standard and special H.S.S., properties, fields of application and limitations. Carbides; Method of manufacturing, different grades, I.S.O. specification, fields of application and limitations. Ceramics; Manufacturing method, properties, different compositions, fields of applications and limitations.

02	Tool life Definition, flank wear and crater wear, preliminary failure and ultimate failure mechanism of tool wear, effect of speed, feed, depth of cut, tool material and geometry on tool life , Taylor's tool life equation, Taylor exponent and constant, Experimental methods to find Taylor exponents. Economics of machining- components of machining cost, machine cost, non production cost, tool cost; components of tool cost; tool change cost; tool regrinding cost, tool inventory cost, tool depreciation cost ,Optimum cutting speed and tool life for maximum production as well as minimum cost of production.	06
03	Design of cutting tools; Nomenclature of Single point tools, Machine Reference and Tool Reference Systems ,definition of various angle of single point tool as per Machine Reference and Tool Reference Systems; (American nomenclature will be followed in further discussion),Inter-relationship among different systems of nomenclature for tool angles. Factors influencing the choice of shape, size, and angle of single point cutting tool for various machining conditions, constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools throw away tip type tools. Design of shanks and cutting part details for HSS and Carbide tools.	08
04	Form Tools: various types such as flat form tool, tangential form tool, circular form tool; constructional details and fields of application ; profile correction in all types of form tools with and without rake angle. Broaches: Details and nomenclature, design steps for pull and push broaches, design of internal and external broaches.	04
05	Drills: Constructional features of two fluted drills, nomenclature, choice of point angle, helix angle for different machining conditions, rake and clearance angles in drills, web thinning, margin relieving, double point angle, spiral lip and special grinding to reduce the effect of chisel edge; carbide tipped drills, design features of core drills, countersinks, counter bores and spot facers Reamers: Constructional features of hand reamer, machine reamer, adjustable reamer, expansion reamer, carbide tipped and insert type,	06

	nomenclature. Design of reamer diameter, chamfer, choice of helix angle, number of teeth, tooth form, back taper, shank etc. Taps: Hand taps and machine taps, constructional features, nomenclature, design of thread profile, number of flutes, flute shape, chamfer, length, helical fluted taps, collapsible taps	
06	Milling cutters: Peripheral milling cutters, various types, choice of diameter and number of teeth, rake angle, clearance and form of flutes, helix angle of flutes and relief angle, form milling cutters, design of form relieved milling cutters. Constructional features of inserted blade milling cutters. Face milling cutters; Solid and inserted blade type, nomenclature of details and angles, selection of angles, diameter and number of teeth, constructional details of inserted blades, throwaway tip type face mills, constructional features of end mill cutters. Gear teeth cutters. Gear milling cutters, standard set of cutters, limitations on accuracy, design of gear teeth milling cutters both disc and end mill type cutters Gear hobs: Design of rake profile, lead, straight and helical gears, diameter and length of hobs, pre- shave, pre-grinding, semi topping, full topping hobs, carbide tipped hobs. Gear shaper cutters: Disc type and shank type cutters, details and angles, pre-shave, pre-grinding, semi topping cutters	10

Term work:

1. At least one class test must be conducted in the middle of the semester & 10 marks weight age must be assigned during evaluation of term work.
2. Design and drawing of minimum three cutting tools.
3. At least five numerical problems on metal cutting.
4. Experiments on any two machine tools for determining cutting forces and studying chip formation.

Text Books

1. Metal Cutting Theory & Practice by Sen and Bhattacharya, New Central Book Agency,1969
2. The Machining of Metals by Aarmarego and R.H.Brown, Prentice Hall Inc.1969
3. Metal Cutting and Tool Design by Arshinov
4. Typical Examples and Problems in Metal Cutting by N.Nefedov, K.Osipov, Mir Publishers,1987
5. Production Technology by HMT Handbook, TMH
6. Metal Cutting Principles by Shaw, Milton, Oxford .Uni. Press,2004

Reference Books

1. Fundamentals of Metal Machining and Machine Tools by G. Boothroyd, Tata McGraw Hill,1975
2. ASM Handbook, Vol 6: Machining, Printed in USA,1999
3. Metal Cutting and Machine Tools by Juneja and Shekho, Wiley
4. Exp. Methods in Metal Cutting by V.C.Venkatesh, PHI, 1982

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-V	
SUBJECT: **Materials Technology**			
Periods per week 01 Period of 60 min	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total	-	150

Objective:

Prepare theoretical base for understanding of the spectrum of applications of materials in machining, forming and other related manufacturing operations in Production/Mechanical Engineering.

Approach:

Emphasis on concepts and phenomena in relation to Engineering and other applications.

Details of syllabus:

Module No	Description	No of Hours
1	**Structure of Materials** **1.1. Solidification and structure of metals.** 1.1.1. Formation of solids from liquids of pure metals and alloys, ingot defects and their remedies. 1.1.2. Single crystal and polycrystalline structure. Classification of crystal system, crystal structure, unit cell, co-ordination number, atomic packing factor, crystallographic notations. **1.2. Crystal imperfection.** 1.2.1. Definition, classification, Point defects: vacancy, interstitial, impurity atoms, their formation and effects. Dislocations: Edge and screw dislocations, their significance. Surface defects: Grain boundary, sub-angle grain boundary, stacking fault, and their significance. 1.2.2. Dislocation generation at Frank Reed sources. Edge-Screw Dislocation interactions. **1.3. Deformation.** 1.3.1. Mechanisms of deformation, Critical resolved shear stress. Slip systems of FCC, BCC, HCP metals. 1.3.2. Elastic deformation & Plastic deformation and their significance. 1.3.3. Deformation in Single and Polycrystalline materials. Strain Hardening and its significance. Strain Hardening and its significance.	11

2	**Ferrous Materials** 2.1. Classification of Steels : Plain Carbon Steels, High Strength Low Alloy Steels, Tool Steels, Stainless Steels, Maraging Steels, Creep Resistant Steels and Steels for Low Temperature Applications. ISI Designations 2.2. Classification of Cast Irons: Gray, Malleable, Nodular, Meehanite and other Alloy Cast Irons. ISI Designations 2.3. Engineering & other Applications of Ferrous Materials: Construction, Automobile, Marine, Aerospace, Electrical, Electronics & Telecom Engineering, Chemical & General Engineering	07
3	**Heat Treatment of steels** 3.1. Iron-Iron Carbide diagram- Steel and Cast Iron portions of Iron-Iron Carbide diagram, application of Lever Rules. Formation of Ferrite, Austenite, Pearlite and Ledeburite. 3.2. TTT and CCT diagrams and their industrial significance. Formation of Bainite and Martensite. 3.3. Basic Heat Treating Processes: Annealing, Normalizing, Hardening, Tempering, Aus-tempering,Mar-tempering and Maraging. 3.4. Basic Surface Hardening Processes: Carburizing, Nitriding, Cyaniding, Flame Hardening and Induction Hardening.	07
4	**Non Ferrous materials,Alloys & Theoty of alloying** Basic Treatment Only 4.1. Important non ferrous materials like Aluminium, Brass, Copper ,Nickel, Chromium, Tin, Zinc – Their properties and applications. 4.2. Phase diagrams and their importance. Eutectic, Eutectoid, Peritectic and Solid Solution type of alloys. Intermediate alloys. 4.3. 4.3 Important alloys of aluminum, copper, titanium, Brass, Berillium, nickel, tin and zinc with applications.	06

5	**Non metallic materials** **5.1. Ceramics.** 5.1.1. Definition, Comparative Study of Structure and Properties of Engineering Ceramics with reference to Metallic Materials, Toughening Mechanisms in Ceramics. 5.1.2. Applications of Engineering Ceramics: Glass and Glass-Ceramics, Aluminium Oxide, Silicon Carbide, Silicon Nitride, Titanium Carbide, Titanium Nitride , Zirconia, and Refractories **5.2. Polymers.** 5.2.1. Definition; Types and classification, Comparative Study of Structure and Properties of Polymers with reference to other Materials; 5.2.2. Important characteristics ,properties and Applications of Polymers, Polyethylene, PP, ABS, Polyamides (Nylon), polycarbonates, PPS, Poly acetal, Polyesters, acrylics, Silicons, PEK and PEEK Epoxies, Phenolics & Polyurethones	06

6	**Structured Formulations** **6.1 Composites.** 6.1.1. Definition;Classification; Particle-reinforced Composites and Fibre--reinforced Composites; Rule of Mixtures; Sandwich structures. 6.1.2. Applications of Composites: GFRP composites (PMC), Al_2O_3 in Al-alloy(MMC), and Carbon Fibre in Carbon (CMC). Fundamental understanding only **6.2. Nano-structured Materials.** 6.2.1. 6.2.1 Definition and Introduction to Nano-Technology. Unique features of Nano-structured Materials. 6.2.2. Classification of Nano-structured Materials: Nano-crystalline Materials; Carbon Nanotubes; Dendrimers;Nano-intermediates & Nano-composites (Fundamental understanding only). **6.3. Powder Metallurgy.** 6.1.1. Powder manufacturing and powder compaction,Sintering, Slip Casting, 6.1.2. Applications and limitations of Powder Metallurgy.	10

Term work:

1. Based on above syllabus at least six experiments to be conducted and the written report to be submitted with inferences.
2. At least four assignments to be undertaken in the form of an in-depth technical write-up on topics drawn from the above syllabus.
3. One class test to be conducted in the middle of the term for 10 marks.
4. Performance in experiments, assignments and class test to be taken into consideration while evaluating the term work.

Textbooks:

1. Mechanical Metallurgy by G.E. Dieter
2. Engineering Physical Metallurgy by Y. Lakhtin
3. Metgallurgy for Engineers by E. C. Rollason
4. Introduction to Engineering Materials by B. K. Agrawal
5. Engineering Metallurgy Part I & II by R. A. Higgins
6. Material Science by S.L.Kakani & A. Kakani
7. Material Technology by S.B.Barve
8. Materials Science and Engineering by V.Raghavan
9. Engineering Materials by C.P.Sharma
10. The Science & Engineering of Materials by D. R. Askeland & P. P.Phule
11. An Introduction to Materials Engineering by Brian S. Mitchell (2004), and
12. Science for Chemical and Materials ISBN 0471436232, 978047143623

University of Mumbai			
CLASS: T.E. Production Engineering		Semester - V	
SUBJECT: Environmental Studies			
Periods per week (each of 60 min.)	Lecture	2	
	Practical	-	
	Tutorial	1*	
		Hours	Marks
Evaluation System	Theory Examination	2	50
	Practical examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		**75**
* Class wise Tutorial			

Objective: This course is to create environmental awareness, of variety of environmental concerns.

Module	Contents	Hrs
1	The Multidisciplinary nature of environmental studies Definition, scope and importance Need for public awareness	1
2	Natural resources Renewable and non-renewable resources Natural resources & associated problem. a. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. b. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d. Food resources: World food problems overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e. Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	4
3	• Ecosystems • Concepts of an ecosystem. • Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem.	3

	• Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)	
4	Biodiversity and its conservation • Introduction-Definition: genetic species and ecosystem diversity • Bio-geographical classification of India • Value of biodiversity : Consumptive use, productive use, social, ethical, aesthetic and option values • Bio-diversity at global, national, local levels • India as a mega diversity nation • Hot spots of bio-diversity • Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts • Endangered and endemic species of India • Conservation of biodiversity: In- situ and Ex-situ conservation of biodiversity	4
5	Environmental Pollution Definition – • Causes, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear Hazards • Solid waste management: Causes, effect and control measures of urban and industrial wastes • Role of an individual in prevention of pollution • Pollution case studies • Disaster management: floods, earthquake, cyclone and land slides	4
6	Social issues and environment • From unsustainable to sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Re-settlement and rehabilitation of people: Its problems and concerns. Case studies. • Environmental ethics: issues and possible solution • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. • Wasteland reclamation • Consumerism and waste products • Environment protection act • Air(Prevention and control of pollution) act • Water (Prevention and control of pollution) act • Wildlife protection act	4

	• Forest conservation act • Issues involved in enforcement of environmental legislation • Public awareness	
7	Human population and the environment • Population growth, variation among nations • Population Explosion- family welfare program • Environment and human health • Human rights • Value education • HIV/AIDS • Women and child welfare • Role of information technology in environment and human health • Case studies	4
8	**Understanding Existence and Co-existence** Interrelation and Cyclicity between Material order, Bio-order, Animal order and Human order **Understanding the human conduct:** Relationship in Family, Justice in Relationship, Relationship of Human with Nature (Environment), Human Behavior, Human Values, Nature and Morality **Understanding the human society** Dimensions of Human Endeavor and Objectives, Interrelationship in Society, Mutual Fulfillment and Cyclicity in Nature.	6

Theory Examination:

1. Question paper will be comprising of total 7 questions, each of 10 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and covering the all modules.
4. Remaining questions will be mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Term work:

Term work shall consist of minimum five projects (PROJECTS SHALL BE DESIGNED ON THE SAME GUIDE- LINE OF GIVEN TEXT BOOK) and a written test.
The distribution of marks for term work shall be as follows,
Laboratory work (Tutorial/Project and Journal) : 15 marks.
Test (at least one) : 10 marks.
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Recommended Books:

1. Erach Bharucha, text book of environmental studies, Universities Press/Orient Blackswan
2. Jagdish Krishnaswami, R J Ranjit Daniels, 'Environmental Studies", Wiley India Private Ltd. New delhi
3. Anindita Basak, 'Environmental Studies", Pearson
4. Deeksha Dave, "Text book of , 'Environmental Studies", Cengage learning, Thomason India edition
5. Benny Joseph , 'Environmental Studies", Tata McGRAW HILL
6. D L Manjunath, , 'Environmental Studies",Pearson
7. R Rajgopalan, , 'Environmental Studies", Oxford
8. Alok Debi, 'Environmental science and Engineering", University press
9. A. Nagraj, Jeevan Vidya- A Primer.

SEMESTER VI

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Process Engineering And Tooling**			
Periods per week 01 Period of 60 min	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total	-	150

Objective;

Develop capability for estimating and assigning process parameters and Variables for the manufacture of simple engineering components.

Approach:

Emphasis on concepts, procedures, practices and case studies.

Weightage :

Proportional to the numbers of 'Hrs' indicated in the right column below:

Details of syllabus:

Module No	Description	No of Hours
1	Product Engineering and Process engineering Definitions, Factors to be considered while developing the product, product development principles, functions of product engineering department, interaction of product engineering with process engineering .Role of process engineering department in manufacturing organization, organization chart, functions of process engineering department	08
2	Preliminary Part Print Analysis & Work piece control General characteristics, determining the principal processes, alternate processes, functional surfaces of the work piece ,areas for processing, nature of work to be performed, finishing and identifying operations, process picture and its applications and uses, case study for understanding preliminary part print analysis Work piece control Variables affecting manufacturing process, need for work piece control, work piece control techniques, importance of geometric, dimensional and mechanical control, case studies for explaining work piece control	10
3	Tolerance Design Rules for adding and subtracting tolerance, tolerance stacks, design and process tolerance stacks, tolerance chart, purpose and use of tolerance chart, definitions and symbols ,determining lay-out of tolerance chart, stock removal, constructing and balancing of tolerance chart ,geometric dimensioning and tolerancing (GD &T)	07
4	Classifying operations, selection of equipment, process pictures, product and process critical area, selection of equipment, operation planning, operation routing, tool layout for turning and other operations	12

	for production Lathe, case studies for detailed process planning with details of sequence of operations ,machine or equipment used, machining parameters i.e. cutting speed, feed, depth of cut, tooling and gauge details ,cutting tools specifications and gauge details machining time calculations along with process pictures .	
5	Traub single spindle automat and its tooling , tool layout and cam design for parts production on Traub.	05
6	Discussion of high speed production machines, SPM, transfer line and other mass production machines-Preliminary treatment only, in-process gauging and multiple gauging, Discussion of production on CNC machines. Computer aided process planning(CAPP), Explanation of CAPP with suitable example. (Basic Treatment only)	06

Term work:

1. At least one class test to be conducted at middle of semester for 10 marks.

2. Detailed process planning of one component (Planning sequence of operations, selection of equipment, speed, feed and depth of cut, special and standard tooling for various operations, gauge details, process pictures and machining time calculation)

3. Tool layout for major operations of a component.

4. Tool layout and cam calculation for component production on Traub.

Text Books:

1. Process Engineering for Manufacturing by Donald F. Eary and Gerald E. Johnson,Prentice-Hall,Inc
2. Production Technology by HMT
3. Manufacturing Engineering by V.Danilevsky, Mir publications,1973
4. Tolerance Design and Analysis by Wade
5. Principles of Control Systems by S.C.Goyal and U.A. Bakshi, Technical Publications ,2006

Reference Books:

1. Fundamentals of Manufacturing Engineering by V.M.Kovan et al, Mir Publications,1979
2. HSS & Carbide tool catalogues for turning, drilling, milling, boring etc. from Tool Manufacturers.
3. Westerman Tables for the Meta! Trade by Wiley Eastern Limited,1991
4. PMT catalogue for Traub.

University of Mumbai			
CLASS:T.E. (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Design of Press Tools and Metal Joining**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total		150

Objective:

Understand principles and mechanics of sheet metal cutting, forming. Tool design for Processes using presses for sheet metal. Understanding various joining processes & techniques.

Approach:

Equal emphasis on concepts, procedure, practices and case studies. Indian standard to be used including present professional practices.

Weightage:

Equal weightage for all chapters.

Details of Syllabus:

Module No	Details	Hrs
01	Shearing of Sheet Metal : Common Press tool operations, Theory of shear action in metal cutting, clearance, cutting force, stripping force and energy requirement with and without shear on press tools, strip layout for blanking ; design of piercing die, blanking die, design and selection of die sets, design of strippers, methods of fixing punches, location stock stops, Fine blanking, shaving, trimming and compound die (basic treatment only)	06
02	Forming of sheet Metal: Sheet metal forming operations (drawing & bending only), metal flow in forming operations; reduction factors and redrawing limits, draw clearances, drawing and blank holding pressures for cylindrical draws only, draw punch and die radii, defects in drawn as well as bent parts, drawing test, presses for drawing/ bending, bend radius, development of blank for above operations, spring back, bending and bottoming forces, Ironing, Bending dies & press brake.	12
03	Progressive Dies for Sheet Metal Parts : Selection progressive dies, stock guides, stock lifters, strippers, pilots, basic types, bridges and carriers, strip layout & development for progressive die, development of die around the strip design, splitting the die block for manufacture basic layout practice, design of various simple progressive dies.	16
04	Equipment for sheet Metal Operations : (preliminary treatment only) Types of presses, overloading of presses(load, torque and energy considerations)	02
05	Gas and Arc welding, Resistance and radiation welding, Solid state and Thermochemical welding, Soldering and brazing processes.	06
06	Types of Joints: mechanical & fabricated joints, joint preparations, thermal cutting, basic requirements and setups for joining processes. Weldability, thermal stresses, inspection and testing of welds. Safety in Welding.	06

Term Work:

1. At least one class test to be conducted at middle of the semester for 10 marks & performance to be taken into consideration while evaluating the term work
2. Design and drawing (Complete) of
   I. Blanking or piercing die
   II. Bending die.
   III. Simple Progressive die with minimum four stages.
   IV. Joining Fixture.

References :

1. Fundamentals of Tool Design By ASTME
2. Tool Design By Donaldson
3. Press Working By ary and Reed
4. Press Tools By PaQuin
5. Press Tools By Osterguard
6. Chipless Machining By C.H.WICK
7. Tool Engineers Hand Book By ASTME
8. Hand Book of Press Tools By ASTME
9. Welding Technology By O P Khanna
10. Metals Handbook By ASM

University of Mumbai			
CLASS:TE. (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Operations Research**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		125

Objective: Introduce the subject as a logical, quantitative approach to managerial and real life problems with emphasis on production and business applications.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Equal weightage for all chapters

Details of Syllabus

Module No.	Details	Hrs
01	Linear Programming, Formulation of problems and graphical	16

	solutions, Characteristics of solutions, Simplex method, Significance of simplex tableau. Big-M method, Two-phase method, Types of solutions such as feasible/infeasible, generate/degenerate, optimal/suboptimal, unique/alternate/ infinite optimal, bounded/unbounded: their interpretations from simplex table, Duality, dual problem formulation, sensitivity analysis for variation of one parameter at a time. Assignment, Transportation, Network models: Minimum spanning tree problem.	
02	Dynamic Programming Models: Bellman's optimality Principle functional equation, backward and forward recursions stages.	06
03	Game Theory or Competitive Strategies : Limited to two person zero sum games, pure and mixed strategies, graphical methods.	06
04	Queuing Systems, queuing models: Poisson-exponential single server model with infinite and finite population.	06
05	Simulation Models: Monte Carlo or experimenting method based on probabilistic behaviour data and random numbers, application in probabilistic real life problems.	06
06	Project Management: Programme evaluation and review technique, critical path method, Crashing of Network , Resource Leveling	08

Term Work

1. At least one class test at the middle of the semester for 10 marks performance to be considered while evaluations of term work.
2. At least two problems on all the above chapters.
3. One group presentation (Maximum four students in one group) on a comprehensive case study from manufacturing area applying OR technique/techniques.

References

1) Operations Research
   By An introduction Hamdy A Taha Macmillan
2) Operations Research
   By Hira and Gupta
3) Quantitative Techniques in Management
   By N.D.Vora TMH New Delhi
4) Operations Research
   By SD Sharma; Kedar Nath Romnath & Co.Meerut
5) Introduction to Operations Research
   By Billy E.Gillet; TMH
6) Principles of Operations Research
   By Harvey M,Wagner,Prentice Hall
7) Introduction to Operation Research
   By Hillier and Lieberman McGraw Hill
8) Operation Research
   By Gupta & Kanti Swaroop S.Chand

University of Mumbai			
CLASS: TE (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Mould And Metal Forming Technology**			
Periods per week 01 Period of 60 min	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	4	100
	Practical Examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total	-	150

Objective: To study and analyze casting, moulding and forming processes for ferrous and non ferrous metals and plastics. To study and design sand moulds, die-csting dies, metal forming rolls, and multi-cavity forging dies.

Approach :

Qualitative and Quantitative approach as applicable as per the syllabus with emphasis on application.

Detailed syllabus

Module No.	Description	No of Hours
1	1. <u>Introduction to Casting Metallurgy.</u> 1.1. Solidification of metals: Freezing of pure metals and alloys. 1.2. Casting of Iron-based alloys: Role of C, Si and other alloying elements in solidification 1.3. Melting practices: Cupola, Arc and Induction furnaces.	06

2	**2. <u>Mould design and forming for casting metals</u>** 2.1. Mould materials: Moulding sand; Constituents of moulding sand and its property requirements; Testing of moulding sand - Grain fineness number, Compression strength and Permeability. 2.2. Design and manufacture of Patterns and Cores: Pattern allowances, Types of patterns, Core print, Pattern design and manufacture, Core making. 2.3. Design and manufacture of gating system : Pouring basin, Sprue, Runners and Ingates. 2.4. Design and manufacture of feeding system: Caines' equation, Chvorinov's mould constant, Use of chills and padding, risering. 2.5. Defects in cast components.	08
3	**3. Special Casting Process & Mould Forming For Polymeric Materials** **3.1. <u>Die design and manufacture for pressure-casting of non-ferrous metals</u>** 3.1.1. Principle of Gravity-, Hot chamber- and Cold chamber die casting processes. 3.1.2. Design and manufacture of die-casting dies and tools for Cold chamber die Casting. 3.1.3. Advancements in die casting processes –Squeeze asting, Thixo-casting and Rheo-casting processes; Defects in die cast components. 3.2. **<u>Lost Wax Process and Mould Forming for polymeric materials</u>** 3.2.1. Investment Casting: Use of wax as the moulding material; Process description; Features and advantages; Fields of application; Rapid Prototyping for Investment Casting.	08

	3.2.2 Injection Mould: Stages in moulding process; Moulding cycle; Layout of injection mould including gating system.	
4	**4. Introduction to Plastic forming of metals** 4.1. Tension Test: True Stress-True Strain, Yield Strength,Hollomon's Equation, Strain Rate, Strain Hardening, Recrystallization, Effect of Friction, Effect of temperature; Compression Test; Problem solving. 4.2. von Mises and Tresca's Yield Criteria; Plastic deformation under plane stress and plane strain conditions; Levy-Mises equations; Prandtl-Reuss equations; (No derivation required). Problem solving.	06
5	**5. Forging & Rolling of metals** 5.1. **Forging of metals** 5.1.1. Forging hammers, Presses and Horizontal upset forging machines: Construction and principle of operation. 5.1.2. Single- and multi-impression closed die forging process; Design and drawing of multi-impression drop-forging, die-set using fuller, edger, bender , blocker and finisher , cavities with flash and gutter. Defects in forged products. **5.2. Rolling of metals** 5.2.1. Longitudinal, Cross and Cross-spiral Rolling; Contact Angle; Neutral angle; Coefficients of spread and Elongation; Forward slip and backward slip; Forces and stresses in longitudinal rolling. 5.2.2. Rolling Mills: Blooming-, Billet-, Slabbing,- Plate- and Structural mills and their layouts. 5.2.3. Design and drawing of Continuous Billet Mill Roll-grooves using diamond, square, oval and round passes. Roll passes for rolling rails, beams, angles and channels; Production of seamless tubes by rolling; Defects in rolled products.	16

6	6. **Extrusion of metals and Miscellaneous metal forming processes** 6.1. Types of extrusion(forward, backward, hydrostatic), variables affecting hot extrusion force and pressure, dead metal zone, pattern of metal deformation in extrusion. 6.2. Analysis of extrusion process, lubrication in extrusion, production of seamless pipe and tubing by extrusion, extrusion defects. Problem solving. 6.3. Wire drawing : Principle of operation and applications.	04

Term work:

1. Design and drawing of sand mould
2. Design and drawing of a cold-chamber die-casting die.
3. Design and drawing of grooved rolls for metal forming.
4. Design and drawing of multi-impression forging die.
5. One class test in the middle of the term must be conducted for 10 marks and performance to be considered during evaluation of the term work.

Textbooks:

1. Metal Casting: A Sand Casting Manual for the Small Foundry
   Vol. II : by Stephen D. Chastain (2004), ISBN 0-9702203-3-2.
2. Metal Casting : by T.V. Ramana Rao.
3. Manufacturing technology : by P.N. Rao.
4. Foundry Engineering : by P.L. Rao
5. Die Casting: by H.H. Doehler.
6. The Diecasting Handbook: by A.C.Street (2nd Edition), Portcullis Press, Redhill, U.K.(1990).
7. Handbook of Lost Wax or Investment Casting: by James E. Sopcak.
8. "From Clay to Bronze": by Tuck Langland (1999).
9. Plastics Engineering Handbook of the Society of the Plastics Industry,INC. (5th Edition) : by M.L.Berins(1994) , ISBN 041 2991810 (Publisher ITP).
10. An Introduction to Materials Engineering and Science for Chemical and Materials Engineers: by Brian S. Mitchell (2004), ISBN 0471436232,

9780471436232, (Publisher Wiley-IEEE).

11. Mechanical Metallurgy: by George E. Dieter.

12. Metals Hand Book, Vol.14 (Forming and Forging): by ASM.

13. Forging Die Design: by Sharan, Prasad and Saxena.

14. Forging Handbook-Forging Methods: by A. Thomas (Publisher-Drop Forging Research Association, Shepherd Street, Sheffield, 7BA).

15. Metal Forming Technology: by Dr. R. Narayanasamy, ISBN 81-7619-002-0 (Ahuja Book Company Pvt. Ltd., New Delhi-110002).

University of Mumbai			
CLASS:T.E. (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Production And Operations Management**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	25
	Oral Examination	-	-
	Term Work	-	25
	Total	-	**150**

Objective- As a first course in the management aspect of the discipline, develop on understanding of the short and medium term industrial engineering and production management functions of production at middle and operational levels.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Equal weightage for all chapters

42

University of Mumbai			
CLASS:T.E. (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Production And Operations Management**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	25
	Oral Examination	-	-
	Term Work	-	25
	Total	**-**	**150**

Objective- As a first course in the management aspect of the discipline, develop on understanding of the short and medium term industrial engineering and production management functions of production at middle and operational levels.

Approach

Emphasis on concepts, principles and analytical treatment supplemented by problem solving.

Weightage

Equal weightage for all chapters

Details of Syllabus

Module No.	Details	Hrs
01	Industrial Engineering: Industrial Engineering and productivity, Methods Study, Work Measurement , Maynard Operations Sequence Technique (MOST), Ergonomics, Design of work place/facilities. Plant Layout, Physical environment : sound, lighting, Ventilation & vibration, Safety.	10
02	Product Engineering: Product research, development and design; design for manufacturing, production systems : Job order, batch production, and mass production; Group Technology, Throughput analysis, Industrial waste, pollution, control and disposal management,	7
03	Production Analysis: Production systems, value adding conversion process, resources and optimum allocation; systems approach, PPC function and its interrelationship with other functions, Line balancing	10
04	Manufacturing Management: Aggregate planning, capacity planning. Batch size decision, Production control, Project management.	8
05	Logistics: Supply chain management, Materials Management. Bill of material, Quality planning, Economic order quantity (EOQ), and different material ordering systems, inventory control and stores systems, ABC analysis.	6

06	Information Support: Integrated approach to the requirement planning and scheduling, MRP-I, MRP-II, ERP, JIT system, SMED, Kanban, Management information System, Computer applications.	7

Term Work

4. At least one class test at the middle of the semester for 10 marks, performance to be considered while evaluation term work.
5. At least four assignments on the above chapters.
6. Preparation of seminar on one topic to be prepared by group of maximum of four students.

REFERENCES :

1. Computer Aided Production Management, By Mahapatra , PHE
2. Operations Management Theory & Problems, By J. G. Monks, MGH International
3. Elements of Production Planning and Control, By Samuel Eilon, Universal Publicity Corporations 1991
4. Operations Management, By McLain J.O. and Thomal L.J. Prentice Hall of India Ltd.
5. Production Systems: Planning Analysis and control, By Riggs. J.L.John Wiley and Sons.
6. Production Control, By Biegel, J.E.Prentice Hall of India Ltd.
7. Operations Management, By Chary S N.
8. Work Study, By International Labour Office, Geneva
9. Work Study and Ergonomics, By H.S.Sham, Dhanpatrai
10. Time and Motion Study, By Ralph Barnes, Asia Publising
11. Most Work Measurement Systems, By Kelli B.Zandin Marcel Decker Inc N.Y.
12. Human Factors in Engineering and Design, By Sanders and Mc Cormack MaGraw Hill
13. Introduction to Ergonomics, By R.S.Bridger MaGraw Hill

University of Mumbai			
CLASS:T.E. (PRODUCTION ENGINEERING)		Semester-VI	
SUBJECT: **Machine Tool Design**			
Periods per week **01 Period of 60 min**	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical Examination	-	-
	Oral Examination	-	-
	Term Work	-	25
	Total		**125**

Objective: Understanding design principles ,procedures of and their significance of basic machine tools and familiarization with use of hand books and relevant codes of practice.

Details of Syllabus

Module No	Details	Hrs
01	Introduction to machine Tools : Types and Capabilities of Various ———	07

	machine tools, constructional, design and operational features. General purpose, single and special purpose machine tool. 1.2. Machine tool structures: Materials of machine tool structures, profiles of machine tool structures, static and dynamic stiffness. Design of lathe bed, bending strength, designing for rigidity, methods of enhancing rigidity. Design of pillar drill column, deflection of column. 1.3. Design of machine tool guideways: type of guideways -shapes, materials of guideways, guideway clearances and wear compensation techniques. Design of guideways for wear and stiffness. Elementary treatment of hydrostatic guideways.	
02	2. Machine Tool Drives 2.1. Design of machine tool drives: Stepped and Stepless speed outputs, selection of spindle speed ranges, construction of speed diagrams, layout of speeds on arithmetic and geometric progression, kinematic advantages of geometric progression series, selection of values of common ratio and design of gear boxes for feed and speeds having 2-3 stages and 4-12 speeds. 2.2. Stepless drives: Mechanical stepless drives- single disc, double disc and cone disc transmissions, speed regulation by epicyclic gear train, positive infinitely variable drives(PIV drives) – Kopp's and Svetozarav's drives. 2.3. Feed boxes: Quadrant change gear mechanism, speed boxes with gear cone and sliding key, Nortan gear drive, Meander gear drives, gear boxes with clutched drive, Scohpke drive and Ruppert drive.	20
03	Design of clutches: Design of plate clutches-Materials of clutch plates, linings & running conditions(wet & dry) clutch plate sizes, design of clutch springs and operating lever.	05
04	Design of power screws: Power screw profiles and selection, design of machine tool power screws based on strength, buckling and stiffness,	05

	power requirements and efficiency, mounting of power screws elementary treatment of ball recirculating power screws.	
05	Design of machine tool bearings: Bearing materials, characteristics and selection. Types of bearings- selection and applications, bearing designations (ISI, SAE and SKF designations). Design of ball and roller bearings- static and dynamic load bearing capacities, cubic mean load, selection of bearing from hand book. Design of journal bearings. Assembly, mounting and maintenance of bearings.	08
06	Acceptance tests on machine tool: Significance, safety concepts, performance and geometrical tests on lathe, milling, drilling and shaping machines	03

TERM WORK:

1. At least one class test carrying weightage of 10marks.
2. Design of gear box (Max.12 speeds)-Drawing of structural diagram, speed chart, gearing, deviation diagrams & Shafts (at least 2 designs).
3. Design and drawing of machine tool slide way profiles.
4. Design and drawing of machine tool structure profiles.
5. Demonstration of acceptance test on at least one machine tool.
6. Drawing of gear box assembly
7. Assignments involving at least 2 questions/problems each from chapters 1, 7, 8 and 9.

References :

1. Machine tool design hand book: Central Machine Tool Research Institute, Bangalore.
2. PSG Design Data book: PSG College of engineering and technology, Coimbatore.

3. Principles of machine tools: Sen and Bhattacharya.

4. The design and construction of machine tools: H.C.Town.

5. Machine tool Engineering: G R nagpal - Khanna Publishers.

6. Design of Machine tool: S.K.Basu & D.K.Pal – Oxford & IBH Publishing Co .

7. Machine tool design & Numerical Control: N.K.Mehta.-Tata MGH

8. Machine tools: Koenigsberger.