UNIVERSITY OF MUMBAI

Bachelor of Engineering

Production Engineering

Third Year (Sem. VI)

Revised Syllabus (REV- 2012) w. e. f.

Academic Year 2014 -15

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

T. E. (Production) Sem.-VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEC601	Process Engineering and Tooling	4	2	4	1	5
PEC602	Design of Press Tool and Metal Joining	4	2	4	1	5
PEC603	Operations Research	3	--	3	--	3
PEC604	Mould and Metal Forming Technology	4	2	4	1	5
PEC605	Production and Operations Management	4	2	4	1	5
PEC606	Machine Tool Design	4	2	4	1	5
	TOTAL	**23**	**10**	**23**	**5**	**28**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
PEC601	Process Engineering and Tooling	20	20	20	80	03	25	25	150
PEC602	Design of Press Tool and Metal Joining	20	20	20	80	03	25	25	150
PEC603	Operations Research	20	20	20	80	03	--	--	100
PEC604	Mould and Metal Forming Technology	20	20	20	80	03	25	25*	150
PEC605	Production and Operations Management	20	20	20	80	03	25	--	125
PEC606	Machine Tool Design	20	20	20	80	03	25	--	125
Total		**--**	**--**	**120**	**480**	**--**	**125**	**75**	**800**

*** Only ORAL examination based on term work and syllabus**

Course Code	Course/Subject Name	Credits
PEC601	**Process Engineering and Tooling**	**4+1**

Objectives

1. To familiarize with the significance of process engineering and its relevance to manufacturing operations.
2. To develop skills in preparing machining sequence and estimate manufacturing time.
3. To acquaint with the significance and control of tolerance in design & manufacturing.
4. To appraise the students with basics of process and operation planning.

Outcomes: Learner will be able to…

1. Read and analyze part prints & decide sequence of manufacturing operations.
2. Acquire capability in preparing process and tolerance control charts.
3. Develop capability in designing cams for automats.
4. Get oriented with CNC and related software tools.

Module	Details	Hrs.
01	**Process Engineering** Differentiation between Product Engg and Process Engg. Role of process engineering in a manufacturing setup, functions of process engineering. Determining machining sequences - criteria and manufacturing sequence.	**04**
02	**Preliminary Part Print Analysis** 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 and case study for understanding preliminary part print analysis. **Work piece control** Variables affecting manufacturing processes need for work piece control, work piece control techniques, importance of geometric, dimensional and mechanical control and case studies for explaining work piece control.	**10**
03	**Tolerance Design** Dimensional Analysis: Types of dimensions, concept of baseline dimension, basic geometric dimensioning and tolerance (GD & T). 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.	**08**
04	**Process planning** 4.1 Classifying operations (Study of Basic Processes Operations, Principal Processes and Auxiliary Processes. Identification of major, critical, qualifying, re-qualifying and supporting operations), product and process critical area, selection of equipment and Tooling. 4.2 Computer Aided Process Planning (CAPP): CAPP -variant approach and generative approach.	**06**

05	**Operation Planning** Process plan sheet design for complete manufacturing part with details of sequence of operations, machine or equipment used, Process pictures, machining parameters i.e. cutting speed, feed, depth of cut, tooling and gauge details, cutting tools specifications and gauge details machining time calculations. Tool layout for turning on production lathe. **Other aspects of Process Engg.** Introduction to high speed machines, SPM, transfer line and other mass production machines-Elementary treatment only, in-process gauging and multiple gauging. ERP SOFTWARE (PPC module -only introduction).	**14**
06	**Cam Design for Automat** Single spindle automat and its tooling, tool layout and cam design for parts production on Single spindle automat.	**06**

List of Exercises

1. Part print analysis of one component.
2. Tolerance Chart Design.
3. Process Planning Sheet with process picture.
4. Tool Layout for production Lathe.
5. Cam design for Automat.

Term Work

Term work shall consist of assignments based on the syllabus and exercises as per the above list.

The distribution of marks for term work shall be as follows:

- Laboratory work (Experiment/ programs and journal): **15** marks
- Assignments: **05** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Practical/Oral Examination

Each student will be given a small exercise based on syllabus, which will be assessed/verified by examiners during the oral examination.

The distribution of marks for oral-practical examination shall be as follows: Exercise …… 15 marks
Oral …… 10 marks

1. Evaluation of practical/oral examination to be done based on the performance of design task.
2. Students work along with evaluation report to be preserved till the next examination.

Theory Examination

In question paper, weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Process Engineering for Manufacturing*, Donald F. Eary and Gerald E. Johnson,Prentice-Hall, Inc.
2. *Production Technology*, HMT.
3. *Manufacturing Engineering*,V. Danilevsky, Mir publication.
5. *Tolerance Design and Analysis,*Wade.
6. *Fundamentals of Manufacturing Engineering*, V.M. Kovan et al, Mir Publications.
7. *HSS and Carbide Tool Catalogues for Turning, Drilling, Milling, Boring etc. from Tool manufactures.*
8. *Westerman Tables for the Metal Trade*, Wiley, Eastern Limited.
9. *PMT Catalogue,* Traub.

Course Code	Course/Subject Name	Credits
PEC602	**Design of Press Tool and Metal Joining**	**4+1**

Objectives

1. To familiarize with sheet metal working techniques for design of tools & machinery.
2. To acquaint with various processes for production of sheet metal components.
3. To impart knowledge on various metal joining techniques.

Outcomes: Learner will be able to…

1. Identify press tool requirements to build concepts pertaining to design of press tools.
2. Prepare working drawings and setup for economic production of sheet metal components.
3. Get an exposure to concepts on various metal joining operations and their selection.

Module	Details	Hrs.
01	1.1 Common Press working operations (shearing and forming). Benefits and limitations of Press tools. 1.2 Theory of Shearing. Construction of Basic shearing die. Function of different elements of a press tool. Optimum Cutting clearance. Calculations of Cutting force, Stripping force, Centre of Pressure, its importance and calculation. Recommending minimum tonnage of a press. 1.3 Strip layout for blanking. Design of Piercing and Blanking die. Methods of feeding the strip/coil material. Design of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Shear angel on Punches or Die block. 1.4 Design of different types Die sets. 1.5 Basics of Compound die, Shaving die and Trimming die.	**16**
02	Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools.	**04**
03	3.1 Theory of Bending. Basic Bending die construction. Spring back and measures to control it. Blank development of Bend components. 3.2 Theory of Drawing. Metal flow in Drawing & forming operations; reduction factors and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup. 3.3 Defects in drawn as well as bent parts. Presses for drawing/forming and bending operations.	**10**
04	Progressive dies for Sheet metal parts: Selection of progressive dies, stock guides, stock lifters, strippers, pilots. Strip layout & development of die around the strip design. Requirements of a progressive dies.	**07**
05	5.1 Selection of Press and Press setting for Shearing, Bending, Progressive, Drawing dies. Equipment for Sheet metal operations (Basics only). Overloading of presses (load, energy considerations) 5.2 Safety of Operator, Press tool and Press.	**05**

06.	6.1 Types of joints: Mechanical & fabricated joints. Gas, Arc welding, Resistance, Radiation, Solid state and Thermo-chemical welding processes. 6.2 Soldering and brazing processes. Inspection & testing of welds. Defects in welding and their corrective measures. Fixtures in welding. Safety in welding.	

Term Work

Term work shall consist of:

A Design and drawing (complete) of
1. Simple Progressive Die with minimum three stages. (Assembly and details of important elements including BOM)
2. Design of Bending Die.
3. Welding Fixture.

B Assignments on topics drawn from the syllabus.

The distribution of marks for term work shall be as follows:

- Part A **:** **15 marks**
- Part B : **05 marks**
- Attendance (Theory and Practical) **: 05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Practical/Oral Examination

Each student will be given a small task of design based on syllabus, which will be assessed/verified by examiners during the oral examination.

The distribution of marks for oral-practical examination shall be as follows: Design Task …… 15 marks
Oral …… 10 marks

1. Evaluation of practical/oral examination to be done based on the performance of design task.
2. Students work along with evaluation report to be preserved till the next examination.

Theory Examination

In question paper, weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Die Design Fundamentals*, J. R. Paquin.
2. *Basic Die making*, D. E. Ostergaard.
3. *Tool Design*, C. Donaldson.
4. *Press Working*, Eary Reed.
5. *Production Technology*, P.C. Sharma.
6. *Welding Technology*, O. P. Khanna
7. *Welding & Welding Technology*, Richard L. Little.
8. *Die design Handbook, Society of Manufacturing Engineers*
9. *Tool Engineers Handbook*, ASTME

Course Code	Course/Subject Name	Credits
PEC603	**Operations Research**	**3**

Objectives

1. To familiarize with various tools of optimization for effective management of various resources.
2. To acquaint with simulation tools for optimization of various resources in different organizations.

Outcomes: Learner will be able to…

1. Realize and assimilate the need to optimally utilize the resources in various industries.
2. Identify and apply cost effective strategies in various applications.

Module	Details	Hrs.
01	1.1 **Linear Programming:** Linear Programming Problem: Formulation, Graphical solution, Simplex method, Big−M method, Two−phase method, Principle of Duality, Dual Simplex, Sensitivity Analysis. 1.2 **Transportation problem:** Formulation - Optimal solution, Degeneracy. 1.3 **Assignment problem:** Formulation - Optimal solution, Traveling Salesman problem. 1.4 **Sequencing:** Introduction – Flow Shop sequence. Sequencing - n jobs through two machines - n jobs through three machines - Job shop sequencing - two jobs through 'm' machines.	**13**
02	2.1 **Queuing Models:** Introduction - Single Channel - Poisson arrivals - exponential service times - with infinite population and finite population models – Multichannel - Poisson arrivals - exponential service times with infinite population single channel Poisson arrivals. 2.2 **Replacement**: Introduction - Replacement of items that deteriorate with time - when money value is not counted and counted - Replacement of items that fail completely, group replacement.	**06**
03	**Game Theory**: Introduction - Minimax (Maximin) - Criterion and optimal strategy - Solution of games with saddle points – Rectangular games without saddle points - 2 X 2 games - dominance principle - m X2 & 2 X n games, Graphical method.	**04**
04	**Dynamic programming**: Introduction – Bellman's Principle of optimality - Applications of dynamic programming- capital budgeting problem - Shortest Path problem – Minimum Spanning Tree.	**04**
05	**Simulation**: Definition - Types of simulation models - phases of simulation - applications of simulation - Inventory and Queuing problems - Advantages and Disadvantages - Simulation Languages.	**04**
06.	**Project Management:** Programme Evaluation and Review Technique, Critical Path Method, Network Updating, Crashing of Network and Resources leveling.	**05**

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Operations Research: Principle and Practices*, A. Ravindran, D. Phillips, Wiley India.
2. *Operations Research*, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
3. *Operations Research*, R. Panneerselvam, PHI Publications.
4. *Operations Research*, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.
5. *Operations Research*, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.
6. *Operations Research- An Introduction,* Hamdy A. Taha, Pearson Education
7. *Operations Research: Methods and Problems*, Maurice Saseini, Arhur Yaspan and Lawrence Friedman.
8. *Introduction to O.R,* Hiller & Libermann (TMH).

Course Code	Course/Subject Name	Credits
PEC604	**Mould and Metal Forming Technology**	**4+1**

Objectives

1. To study and analyze casting and forming processes like forging, rolling, extrusion and drawing for ferrous and nonferrous metals.
2. To study and design sand moulds, die casting dies, roll grooves and multi impression forging dies.

Outcomes: Learner will be able to…

1. Illustrate intricacies involved in sand mould castings, pressure die castings, rolled products and forged products.
2. Illustrate various forming and casting processes used in manufacturing.
3. Classify equipments and machines used in manufacturing processes such as casting, rolling, forging, extrusion and drawing.
4. Identify melting units used in casting.
5. Identify process defects and their remedies.

Module	Details	Hours
01	**Sand Casting of Metals** 1.1 Mould materials: Moulding sand; Constituents of moulding sand and its property requirements; Testing of sand properties. 1.2 Design and manufacture of Patterns and Cores: Pattern allowances, Types of patterns, Core print, pattern design and manufacture, Core making. 1.3 Design and manufacturing of gating system: Pouring basin, Sprue, Runners and Ingates. 1.4 Design and manufacturing of feeding system: Caine's equation, Modulus method, Chvorinov's mould constant, Use of chills, padding and risering. 1.5 Melting practices: Cupola, Arc and Induction furnaces. 1.6 Defects in cast components and their remedies.	**11**
02	**Special Casting Processes** 2.1 Die design and manufacture for pressure die casting of non−ferrous metals, Principle of Hot chamber and Cold chamber die casting processes, Design and manufacture of die-casting dies for Cold chamber die casting process. 2.2 Advancements in die casting processes-Squeeze casting, Thixo−casting and Rheo-casting processes; 2.3 Defects in die cast components and their remedies. 2.4 Lost Wax Process Investment Casting : Use of wax as the moulding material; Process description; Features and advantages; Fields of application; 2.5 Shell Mould casting: Working principle and application.	**08**
03	**Introduction to Mechanics of Metal Forming** 3.1 Tension Test : True Stress−True Strain 3.2 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).	**04**

04	**Forging of metals** 4.1 Forging hammers, Presses and Horizontal upset forging machines: Construction and principle of operation. 4.2 Single and multi-impression closed die forging process; 4.3 Design and drawing of multi-impression drop forging, die set using fuller, edger, bender, blocker and finisher, cavities with flash and gutter. 4.4 Defects in forged products and their remedies.	**11**
05	**Rolling of metals** 5.1 Longitudinal, Cross and Cross−spiral Rolling; Contact Angle; Neutral point and angle; Coefficients of spread and Elongation; Forward slip and backward slip; Forces and stresses in longitudinal rolling. 5.2 Rolling Mills: Blooming, Billet, Slabbing, Plate and Structural mills (introduction). 5.3 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. 5.4 Production of seamless tubes by rolling. 5.5 Defects in rolled products and their remedies.	**10**
06	**Extrusion of Metals and Miscellaneous Metal Forming Processes** 6.1 Introduction to metal extrusion and basic concepts of extrusion dies. 6.2 Drawing of metals: Principle of operation and applications.	**04**

List of Design Exercises

1. Design and Drawing of Sand Mould Castings.
2. Design and Drawing of a Cold Chamber Die Casting Dies.
3. Design and Drawing of grooved rolls for rolling operation.
4. Design and Drawing of Multi impression Forging Die.

Term Work

Term work shall consist of design exercises as per the above list and at least one assignment involving minimum 2 questions/problems from each module.

The distribution of marks for term work shall be as follows:

- Design and drawings of dies/moulds: 1**5** marks
- Assignments: **05** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Oral examination

1. Oral examination shall be conducted based on term work and syllabus content
2. Examiners are expected to give small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Theory Examination

In question paper, weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Metal Casting : A Sand Casting Manual for the Small Foundry-Vol. 2*, Stephen D. Chastain.
2. *Principles of Metal Casting,* R W Heine, C R Loper, P. C. Rosenthal.
3. *Metal Casting,* T.V. Ramana Rao.
4. *Manufacturing Technology*, P.N. Rao.
5. *Foundry Engineering*, P.L.Jain.
6. *Die Casting*, H.H. Doehler
7. *The Diecasting Handbook*, A.C.Street , Portcullis Press, Redhill, U.K.
8. *Mechanical Metallurgy*, George E. Dieter.
9. *Metals Hand Book−Vol. 14 Forming and Forging*, ASM International.
10. *Forging Die Design*, Sharan, Prasad and Saxena.
11. *Forging Handbook-Forging Methods*, A. Thomas , Publisher-Drop Forging Research Association, Shepherd Street, Sheffield.

Course Code	Course/Subject Name	Credits
PEC605	**Production and Operations Management**	**4+1**

Objectives

1. To familiarize with the concepts, principles and knowledge of analytical problem solving at operational levels.
2. To acquaint with functions of operation management and its interrelation with other business functions.
3. To study key areas of production management and decision making.
4. To acquaint with importance of planning and control in production activities.

Outcomes: Learner will be able to…

1. Identify and analyze operation flows, primary and supporting activities to achieve quality and targets.
2. Conceptualize products/services, select site and plan layout.
3. Get exposure to latest trends in production and operations management.

Module	Details	Hrs.
01	1.1 Generalized model of a production system, life cycle of a production system, evaluation of investments in new product and services, risk analysis using decision trees, product mix decisions, different kinds of production systems, mass, batch, job, FMS, Group Technology & cellular production and MIS. 1.2 Introduction to lean manufacturing.	**10**
02	**Industrial Engineering and productivity** Methods Study, Work Measurement, Maynard Operations Sequence Technique (MOST), Anthropometry - Design of work place/facilities. Physical environment: sound, lighting, Ventilation, vibration and Safety.	**06**
03	Models for Facility Planning, Location Planning, Layout Planning and Demand Forecasting.	**06**
04	Production Planning Models, PPC function and its interrelationship with other functions, Aggregate planning, capacity planning, control, Batch size decision, Line balancing, loading & dispatching. Theory of constraints. Importance of Project Management.	**10**
05	Logistics and Supply chain Management, Push- Pull system, Purchasing Cycle, Procurement & Purchase, Bill Of Materials, Store system – stock valuation and factors considered, Scientific Inventory Management - Economic Order Quantity (EOQ), EOQ Models, Selective Inventory (ABC, VED etc.),Static and Dynamic Inventory Control Models. MRP-I , MRP−II, ERP, JIT inventory systems and KANBAN	**10**
06	6.1 Product and process opportunity- identification and research. Value addition and conversion (Primary activities and support systems). 6.2 Introduction to green manufacturing and sustainable development.	**06**

Term Work

Term work shall consist of at least one assignment from each module and minimum two presentations to be conducted and presented with inferences in group of not more than four (4) students.

The distribution of marks for term work shall be as follows:

- Presentation: **10** marks
- Assignments: **10** marks
- Attendance (Theory and Practical): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

In question paper, weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

References

1. *Operations Management: Theory and Problems*, BY J G Monks, MGH international.
2. *Elements of Production Planning and Control*, BY Samuel Elion, University Publicity corporation.
3. *Operation Management for Competitive Advantage*, By Chase, MGH.
4. *Work Study and Ergonomics*, BY Sham. Dhanpatrai.
5. *Work Study*, By ILO, Geneva.
6. *Production Systems: Planning Analysis and Control*, BY Rigs, Wiley and Sons.

Course Code	Course/Subject Name	Credits
PEC606	**Machine Tool Design**	**4+1**

Objectives

1. To familiarize with constructional & design features of machine tool structures like bed, columns, sideways, guide ways etc.
2. To give exposure to types of drives and drive elements and their selection criteria.
3. To develop skills in designing feed gear boxes, bearings, power screws, clutches etc.
4. To acquaint with the use of standards & hand books to retrieve relevant data for design/selection.
5. To appraise the students about safety and safety standards.
6. To acquaint with the recommended procedure of carrying out acceptance tests & their significance.

Outcomes: Learner will be able to…

1. Use codes and hand books to retrieve relevant data for design and selection.
2. Design machine tool structures & drive elements.
3. Design feed gear boxes, bearings and power screws.
4. Get exposure to requirements like maintaining of expected accuracy levels, parametric optimization, managing wear and tear problems etc.

Module	Details	Hrs.
01	**Elements of Machine Tools** 1.1 Types and capabilities of various machine tools. General purpose and special purpose machine tools. 1.2 **Design of machine tool structures** Design of bed & columns: Materials of construction, Profiles, Static and dynamic stiffness. Designing for strength and rigidity. Methods of enhancing rigidity. Design of simple machine tool columns like pillar drill column etc. on the basis of strength and rigidity. Design of machine tool bed cross-section like lathe bed. Machine tool guideways: Materials of construction, Classification of guideways, Types of slideways, Clearance adjustment and wear compensation techniques, Fundamentals of hydrostatic guideways. Design of guideways for wear and stiffness.	**07**
02	**Design of Speed and Feed Boxes** 2.1 Stepped and Stepless speed outputs, selection of spindle speed ranges, construction of structural, speed, gearing & deviation diagrams, layout of speeds on arithmetic and geometric progression, kinematic advantages of geometric progression series and selection of values of common ratio. 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, Norton gear drive, Meander gear drives, gear boxes with clutched drive, Schopke drive and Ruppert drive. 2.4 Design of gear boxes for feed and speeds having 2−3 stages and 4−12 speeds.	**17**

03	**Design of Belt Drives and Power Screws** 3.1 Design of belts and pulleys: Materials of construction for belts. Types of belts- specifications & selection. Design of flat belt & v- belt pulleys. 3.2 Design of power screws: Materials of construction. Power screw profiles and selection, design of machine tool power screws based on strength, buckling and stiffness, power requirements and efficiency, mounting of power screws elementary treatment of ball recirculating power screws.	**08**
04	**Design of Clutches** 4.1 Design considerations, materials of clutch plates & linings. Running conditions- wet & dry. 4.2 Design of plate clutches involving design of clutch plates, springs & operating lever.	**04**
05	**Design of Machine Tool Bearings** Bearing materials & their characteristics. Types of bearings- selection & application. 5.1 Design of ball & roller bearings: Bearing designation (ISI, SAE, and SKF). Calculation of equivalent load, cubic mean load, static & dynamic load bearing capacities. Selection of ball & roller bearing from handbook. Mounting & maintenance of bearings. 5.2 Design of journal bearings: Terminology. Theory of lubrication, bearing characteristic No., Sommerfeld No., calculations involving bearing dimensions, clearance, coefficient of friction, heat generated, and heat dissipated and power lost in friction. Mounting & maintenance of bearings.	**08**
06	**Safety of Machine Tools & Acceptance Tests** 6.1 Safety concepts, various safety devices incorporated in machine tools to safeguard safety of man, tools and equipment. Introduction to safety standards. 6.2 Acceptance tests on machine tool: Significance, performance and geometrical tests on lathe, milling, drilling and shaping machines.	**04**

List of Design Exercises

1. Design of gear box (Max 3 steps, 12 speeds), structural diagram, speed chart, gearing diagram, deviation diagram. Drawing of gear box assembly. (At least 2 designs)
2. Design and drawing of machine tool guide ways, sideway profiles, wear compensation techniques.
3. Design and drawing of machine tool structure profiles.
4. Demonstration of acceptance test on at least one machine tool.

Term Work

Term work shall consist of design exercises as per the list given above and at least one assignment involving minimum 2 questions/problems from each module

The distribution of marks for term work shall be as follows:

Laboratory work (design and drawings): **10** marks
Assignments: **10** marks
Attendance (Theory and Practical's): **05** marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal Assessment

Assessment consists of two tests out of which; one should be compulsory class test (on minimum 40% of curriculum) and the other is either a class test (on minimum 70% of curriculum) or assignment on live problems or course project.

Theory Examination

In question paper, weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total four questions need to be solved.

NOTE

Use of standard design data books like PSG Data Book is permitted at the examination and shall be supplied by the college.

References

1. *Principles of machine tools*, Sen and Bhattacharya, New Central Book Agency.
2. *Machine tool design and Numerical Control*, N.K.Mehta, Tata MGH
3. *Machine tool Engineering*, G R Nagpal, Khanna Publishers.
4. *Design of Machine tool*, S.K. Basu and D.K.Pal, Oxford and IBH publishing Co.
5. *The design and construction of machine tools*, H.C.Town.
6. *Machine tool design hand book*: Central Machine Tool Research Institute, Bangalore. Tata MGH.
7. *PSG Design Data book*: PSG College of engineering and technology, Coimbatore.