UNIVERSITY OF MUMBAI

Bachelor of Engineering

Production Engineering

Third Year (Sem. V & VI) and Final Year (Sem. VII & VII)

Revised Syllabus (REV- 2012) w. e. f. Academic Year 2014 - 15 and 2015-2016 respectively

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Deans Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Chairman Preamble

Engineering education in India is expanding and is set to increase manifold. The major challenge in the current scenario is to ensure quality to the stakeholders along with expansion. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

As the Chairman, Board of Studies in Mechanical Engineering of University of the Mumbai, I am happy to state here that, the Program Educational Objectives were finalized in a brain storming session, which was attended by more than 20 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Mechanical Engineering. The Program Educational Objectives finalized for the undergraduate program in Mechanical Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals.
2. To prepare the Learner to use modern tools effectively in order to solve real life problems.
3. To prepare the Learner for a successful career in Indian and Multinational Organisations and to excel in their Postgraduate studies.
4. To encourage and motivate the Learner in the art of self-learning.
5. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner's thought process.

In addition to the above, 2 to3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of undergraduate program, course objectives and course expected outcomes from the point of view of a learner are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that even a small step taken in the right direction will definitely help in providing quality education to the major stake holders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai

Program Structure for B. E. Production Engineering

T. E. (Production) Sem.-V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEC501	Computer Aided Design and Finite Element Analysis	4	2	4	1	5
PEC502	Metrology and Instrumentation	3	2	3	1	4
PEC503	Design of Jigs and Fixtures	3	2	3	1	4
PEC504	Machining Science and Technology	3	2	3	1	4
PEC505	Engineering Design	3	2	3	1	4
PEC506	Thermal Engineering	3	2	3	1	4
PEL501	Business Communication and Ethics#	--	2*+2	--	2	2
	TOTAL	**19**	**16**	**19**	**8**	**27**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test2	Avg.					
PEC501	Computer Aided Design and Finite Element Analysis	20	20	20	80	03	25	--	125
PEC502	Metrology and Instrumentation	20	20	20	80	03	25	25	150
PEC503	Design of Jigs and Fixtures	20	20	20	80	03	25	25	150
PEC504	Machining Science and Technology	20	20	20	80	03	25	--	125
PEC505	Engineering Design	20	20	20	80	03	25	25	150
PEC506	Thermal Engineering	20	20	20	80	03	25	--	125
PEL501	Business Communication and Ethics#	--	--	--	--	--	50	--	50
Total		**--**	**--**	**120**	**480**	**--**	**200**	**75**	**875**

* Theory for entire class is to be conducted # Common for all engineering programs

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
PEC501	**Computer Aided Design and Finite Element Analysis**	**4+1**

Objectives

1. To introduce the concepts of computer aided engineering for design & manufacture.
2. To impart knowledge on computer graphics, which are used in diverse areas of engineering.
3. To provide basic knowledge of the finite element analysis.

Outcomes: Learner will be able to…

1. Illustrate software configuration of graphic packages.
2. Demonstrate use of Computer graphics in design.
3. Solve physical and engineering problems with emphasis on Structural and Thermal Engineering applications.

Module	Details	Hrs.
01	**Computer Aided Design** **Introduction** : Need and Utility of CAD systems in industry, Product Cycle, Definition of CAD tools based on their constituents and implementation in a design environment. **CAD Hardware** *:* Types of systems, system considerations, I/O devices, Hardware Integration & Networking	**04**
02	**Computer Graphics** Pixel plotting, Scan conversions of lines & circuits, 2D & 3D transformation, 2D Viewing and clipping. Parallel Projection. Elementary treatment of Hidden lines and surfaces. Cubic spines Bezier curves & B- spines, Animation and Color models.	**14**
03	**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 and DXF	**05**
04	**Finite Element method** 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 nodded triangular elements and four nodded 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 quadrature method, Meshing and Compatibility of elements. Incorporation of boundary conditions and solution of static equations.	**18**
05	**Introduction to Dynamic** Thermal analysis and computational Fluid Dynamics FEM and Dynamic Analysis using FEM (No numerical problems). Equations of motion and formulation of F.E. equations using 1D element for vibration problems (Introductory).	**05**

06	**FEA Software** Features of commercial software's Preprocessor, solver and Postprocessor. Types of elements available with commercial software for different FEA applications (No numerical problems).	**02**

List of Exercises

1. Exercises in Modeling and drafting of Mechanical Components - using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc.
2. Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc. Exercises shall include analysis of Machine elements under Static loads.

Term Work

Term work shall consist of at least one assignment from each module of syllabus and minimum six exercises to be conducted and presented with inferences on topics from syllabus.

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

- Laboratory work (Experiment/ programs and journal) : **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. *CAD/CAM*, Groover and Zimmers
2. *CAD Principles and Applications*, Barr, Krimger and Lazaer
3. *CAD/CAM Handbook*, Teicholz
4. *Principles of Computer Graphics*, William M Neumann and Robert F.Sproul, Mc Graw Hill Book Co. Singapore.
5. *Computer Graphics*, Donald Hearn and M. Pauline Baker, Prentice Hall, Inc.
6. *Computer graphics principles & practices*, Foley, Wan Dam, Feiner and Hughes, Pearson Education.
7. *An Introduction to the Finite element Method*, Reddy, J.N, McGraw Hill.
8. *Finite Element Method in Engineering*, Rao, Pergammon Press.
9. *CAD / CAM*, P.N. Rao, Tata-Mcgraw- Hill.
10. *Mathematical and Procedural Elements for computer graphics*, Roger and Adams
11. *Computer Graphics*, Hearn and Baker, PHI.
12. *Computer Graphics*, Plastock and Gordon, Schamums outline series.
13. *FEM*, Fagan.
14. *FEM* , J.N.Reddy, McGraw – Hill.
15. *A first course in FEM*, daryl L.Logon, Cengage.
16. *Concepts and applications of FEA*, Cook, Malkus , Jhon-wiley.
17. *Mastering CAD – CAM*, Ibarahim Zeid, Tata-Mcgraw-Hill.

Course Code	Course/Subject Name	Credits
PEC502	**Metrology and Instrumentation**	**3+1**

Objectives

1. To acquaint with principles of precision measuring instruments & their significance.
2. To familiarize handling & use of precision measuring instruments/ equipments.

Outcomes: Learner will be able to…

1. Handle & operate precision measuring instruments/ equipments.
2. Analyze simple machined components for dimensional stability & functionality.

Module	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 and Tertiary standards.	**04**
02	Limits, fits and Tolerances 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.	**06**
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.	**04**
04	**Interferometer** : Principles of interface, 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, and roughness standard 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.	**07**
05	**Measurement of Screw Threads** : types of screw threads, definitions, measurement of major and pitch diameter, 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, circular pitch, tooth thickness and width, base tangent method , gear tooth comparator, gear measurement using rollers, master gears and Parkinson tester.	**10**
06	**Special Measuring Machine and Methods**: Profile Projector, 3D 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.	**05**

List of Experiments

1. At least one experiment on GEOMETRIC FEATURES.
2. At least one experiment on ANGULAR MEASUREMENTS.
3. At least one experiment on COMPARATORS
4. At least one experiment on INTERFEROMETRY
5. At least one experiment on THREAD MESUREMENT
6. At least one experiment on GEAR MESUREMENT.

Term Work

Term work shall consist of at least 1 assignment on each module from syllabus and minimum 06 experiments as per above list to be conducted and presented with inferences.

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

Laboratory work (Experiment/ programs and journal):	**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.

Practical/Oral examination

1. Practical examination shall be conducted based on the list of experiments. Examination shall be based on actual handling of instruments and accurate measurement of given parameters.
2. Examiners are expected to evaluate learners' skill of handling the Instruments and accurate measurement of asked parameters and conduct oral based on the syllabus.
3. The distribution of marks for practical/oral examination shall be as follows:
    i. Practical performance …… 15 marks
    ii. Oral …… ……...10 marks
4. 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 *Metrology*, Shotbolt
2. *Practical Engineering Metrology*, K.W.P Sharp.
3. *Engineering Metrology*, I.C. Gupta.
4. *Experimental Methods for engineers*, J.P. Holman.
5. *Instrumentation Devices and System*, C.S. Rangan, G.R. Sarma, V.S. Mani, TMH.
6. *Industrial Instrumentation and Control*, S.K. Singh, TMH.

Course Code	Course/Subject Name	Credits
PEC503	**Design of Jigs and Fixtures**	**3+1**

Objectives

1. To acquaint with concepts pertaining to planning and sequencing of operations.
2. To develop capability to identify and select location and clamping faces/points on jobs.
3. To develop capabilities of designing simple productive and cost effective jigs and fixtures.

Outcomes: Learner will be able to…

1. Demonstrate concepts pertaining to planning and sequencing of operations
2. Identify and select location and clamping faces/points on jobs.
3. Design and develop simple productive and cost effective jigs and fixtures.

Module	Details	Hrs.
01	**Introduction to Tool Design** Production Tooling's(Jigs, Fixtures, Dies etc)and their difference, their Requirement(accuracy, machinability, quantity modifications so as to assist production, Interchange ability, Simplicity, Swarf disposal, Handling, Ease of operation, Skill reduction, Cost reduction). Analysis for Operation planning, sequencing of operations.	**05**
02	**Basic Construction of Jig & Fixture** **2.1 Location & Locating Devices** Locating principles: Degrees of freedom, Redundant location, Fool proofing, nesting. Locators: locators that control work piece from flat surfaces, location from cylindrical surfaces, conical locators, centralizers. **2.2 Clamping & clamping Devices** Requirement of clamping system, Position of clamps. Design of clamps. Clamping devices; examples of typical clamps(multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices). Component distortion under clamping and cutting forces. Material used for different elements of jigs/fixture and recommended hardness where necessary.	**12**
03	**Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces /points choice, cutting tools and means of guiding and supporting Jigs, various types of Jig Bushes, Commonly used drill jigs. Case Study on Drill Jig Design.	**05**
04	**Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, Tool setting & cutter guiding (Tennons & Setting block). Case Study on Milling Fixture Design.	**05**
05	**Introduction to Commonly used Fixtures** Turning Fixture (Chucks, collets, Mandrels) Grinding Fixture, Broaching Fixture, and Welding & Assembly of Jig / Fixture.	**05**
06	**Indexing Jig & Fixture** Introduction. Application of indexing. Essential features of an indexing jig /fixture, Indexing Devices.	**04**

Term Work

Term work shall consist of at least one assignment on each module and minimum two different designs and development of jigs and fixtures assembly (drill jig and milling fixture). The drawings for jigs and fixtures should contain all the tolerances and materials including heat treatment.

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

- Laboratory work (Experiment/ programs and journal): **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.

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. *Jig and Fixture Design Manual,* Erik K. Henrikson, Industrail Press.
2. *An introduction to jig and tool Design,* M.H.A. – Kempster, III Ed.Pub ELBS.
3. *Jigs and Fixture,* P.H. Joshi, THM.
4. *Tool design,* C. Donaldson, George H. Lecain, V.C. Goold, THM.
5. *Jigs and Fixture Handbook,* A.K. Goroshkin, Mir Publication.
6. *Jigs and Fixture,* ASTME.
7. *Non- Standards Calming Devices,* Hiran E. Grant TMH, New Delhi.

Course Code	Course/Subject Name	Credits
PEC504	**Machining Science And Technology**	**3+1**

Objectives

1. To familiarize with the basic concepts of machining science.
2. To acquaint with various single and multipoint cutting tools designing processes.
3. To make the students understand the economics of machining processes.

Outcomes: Learner should be able to…

1. Calculate the values of various forces involved in the machining operations.
2. Design various single and multipoint cutting tools.
3. Select an appropriate tool material for a particular machining application.
4. Estimate machining performance measures like power requirement, cutting time, tool life and surface finish.

Module	Details	Hrs.
01	**1.1 Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's circle of forces, velocity relations. Merchant's theory & modified theory of metal cutting. Concept of specific power consumption in machining. **1.2 Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry. **1.3 Surface Integrity and Cutting fluids:** Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish, geometrical contribution to roughness, edge finishing and residual stress. Function of coolant, types of coolants, choice of coolants for various machining processes. Vapors and mist, cryogenic cooling and dry machining. **1.4 Materials for cutting tools**: Properties of cutting tool materials. Major tool material types. Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools.	**11**
02	**Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life. Taylor's tool life equation. Experimental methods to find Taylor exponents. Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate.	**05**
03	**Design of single point cutting tools**: Different systems of tool nomenclature like MRS, ORS and NRS. Interrelationship among different systems of nomenclature for tool angles. Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools. Design of shanks, cutting tip and chip breakers for HSS and Carbide tools. ISO coding system for tipped tools and tool holders.	**05**

04	**Design of Form Tools and broaches:** Various types such as flat form tool, tangential form tool, circular form tool, constructional details and fields of application. Profile design of flat and circular form tools. Broach nomenclature, design steps for circular pull type, key way and spline broaches.	**05**
05	**Design of hole making tools** **5.1 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 and margin relieving. Design of twist drill. **5.2 Reamers**: Constructional features of hand reamer, machine reamer, adjustable reamer, expansion reamer, carbide tipped and insert type. Design of machine reamer. **5.3 Taps:** Constructional features of hand taps and machine taps. Design of serial taps.	**05**
06	**Design of gear milling cutters:** Types of gear milling cutters, standard set of cutters, limitations on accuracy, design of form disc type, end mill type and gear hobbing cutters.	**05**

Term Work

Term work shall consist of at least five numerical problems on metal cutting and minimum 5 Design sheets based on module numbers 4, 5 and 6.

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

- Laboratory work (Experiment/ programs and journal): **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. *Fundamentals of Metal Machining and Machine Tools, Third Edition* by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group.
2. *Metal Cutting Principles (2nd Edition),* by Milton Clayton Shaw, Oxford University Press.
3. *Cutting Tools,* by P. H. Joshi, A. H. Wheeler Publishing Co. Ltd.
4. *ASM Handbook, Vol. 16: Machining (9th Edition),* by Joseph R. Davis, ASM International .
5. *Fundamentals of Metal Cutting and Machine Tools (2nd Edition),* by B. L. Juneja, G. S. Sekhon and Nitin Seth, New Age International Pvt. Ltd.
6. *Metal Cutting Theory and Cutting Tool Design,* by V. Arshinov and G. Alekseev, Mir publishers, Moscow.
7. *Typical Examples and Problems in Metal Cutting and Tool Design,* by N. Nefedov and K. Osipov, Mir publishers, Moscow.

Course Code	Course/Subject Name	Credits
PEC505	**Engineering Design**	**3+1**

Objectives

1. To study basic principles of engineering design.
2. To acquaint with the concepts of strength design related to various components.
3. To familiarize with the use of design data books & various codes of practice.
4. To make conversant with preparation of working drawings based on designs.

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations.
2. Apply basic principles of machine design.
3. Design machine elements on the basis of strength concept.
4. Use design data books and various standard codes of practices.
5. Acquire skill in preparing production drawings pertaining to various designs.

Module	Details	Hrs.
01	1.1. Introduction - Steps involved in designing, types of designs, considerations in designing, Design−manufacturing interface, material selection, factor of safety and its implications. 1.2. Operational Joints - Introduction to cottered, pinned & threaded joints, & their applications. 1.2.1. Design of cottered joints- socket & spigot type, sleeve & cotter type, jib & cotter type. 1.2.2. Design of pin joints- Knuckle joints, suspension links, etc. 1.2.3. Design of threaded joints- Turn Buckle.	**08**
02	**Design of machine elements subjected to eccentric loading** 2.1. Determination of stresses in machine components with various cross sections. Circular, rectangular, triangular, trapezoidal, T & I sections subjected to direct & bending stresses. (Including stresses at critical sections) 2.2. Stresses in curved members- Design of crane hooks & C-clamps with various cross sections (Circular, triangular, square, rectangular, trapezoidal) (Circular & oval rings to be excluded).	**06**
03	**Design of Shafts, Keys & Couplings** 3.1. Design of shafts 3.1.1. Design of shafts on the basis of strength. Shafts subjected to-bending alone, Torsion alone, combined action of torsion & bending, combined action of torsion & axial loads, line shafts. 3.1.2. Concepts about design of shafts based on rigidity (lateral & torsional rigidity), Implications. 3.2. Design of keys 3.2.1. Different types of keys and applications. Fitting of keys. 3.2.2. Stresses in keys and design of key dimensions. 3.3. Design of couplings: 3.3.1. Classification of couplings & application areas. 3.3.2. Design of flanged couplings, muff couplings, marine type coupling, bushed pin type flexible coupling.	**06**

04	**Design of Gears** 4.1 Types & classification of gears, applications areas, gear materials of manufacture, mounting of gears. 4.2 Design of spur gears-simple gear calculations, Design of spur gears based on beam strength & wear. W. Lewis' & Buckingham's equation.	**03**
05	**Design of bolted, welded & rivetted joints:** 5.1 Design of bolted joints- stresses in bolts, joints for leak proof fluid tight applications (like cylinder to cylinder cover fastening in an IC engine) bolts of uniform strength. 5.2 Design of welded joints- Types & classification of welded joints, applications. Familiarization of AWS code. Strength of welded joints- Transverse & parallel fillet welds. Welded joints subjected to torsion – circulator fillet welds and adjacent fillet welds. 5.3 Design of rivetted joints- Type of rivets and rivetted joints. Failure modes of rivetted joints & efficiency of rivetted joints. Design of rivetted joints for riveting longitudinal & circumferential seams of pressure vessels. Familiarization of Indian Boiler Regulation (IBR) 5.4 Design of bolted, rivetted & welded joints subjected to eccentric loading.	**07**
06	6.1 Design of Springs: Classification and applications, design of helical compression and tension springs, co−axial springs. Design of leaf springs−straight and semi elliptical laminated leaf springs. Strain energy of springs−design of buffer springs. 6.2 Design of Pressure Vessels: Design concepts of thick and compound cylinders, Stresses in thick & compound cylinders. Determination of wall thickness, hoop and radial stresses, nature of hoop and radial stress distribution on cylinder walls.	**06**

List of Assignments

Design exercises in the form of design calculations with sketches and or drawings on following machine system

1. Cotter joint/ Knuckle joint/Turn buckle
2. Shaft, Keys and Couplings
3. Gears
4. Bolted/ Riveted/Welded Joints

Term Work

Term work shall consist of

A. Minimum 3 design exercises from the list which may include computer aided production drawing on A3 size sheets

B. At least one design assignment from each module of syllabus

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

- Part A **:** **10 marks**
- Part B : **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.

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.

NOTE:

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

References

1. *Elements Elements of Machine Design,* -N. C. Pandya and C. S. Shah, -Charotar Publishing House.
2. *Design of Machine Elements,*V. B. Bahandri, -Tata McGraw Hill Publishing Co. Ltd., New -Delhi.
3. *Machine Design,* R.K. Jain, Khanna Publications, New Delhi.
4. *Design of machine elements,* M.F. Spotts, PHI
5. *Engineering Design*, Schaum's Series, Tata McGraw Hill Publishing Co. Ltd., New -Delhi.
6. *Machine Design,* J.E. Taylorand, J.S. Wringley
7. *Design of machine elements,* Faires- Macmillan
8. *PSG Design data book,* PSG publication.

Course Code	Course/Subject Name	Credits
PEC506	**Thermal Engineering**	**3+1**

Objectives

1. To adopt a problem solving approach and be able to apply theory to practice in familiar and unfamiliar situations.
2. To develop an understanding of the principles of thermodynamic cycles, applied to engineering processes, power and refrigeration systems.
3. To develop a body of knowledge in the field of Thermodynamics and Heat Transfer.

Outcomes: Learner will be able to…

1. Conduct thermal engineering experiments as well as analyze and interpret data.
2. Identify, formulate, and solve engineering problems related to Thermal engineering.

Module	Details	Hrs.
01	**Reciprocating Air Compressors** Classification, Terminology, Work and power calculations with and without clearance for single and two stage compression, volumetric efficiency and FAD, Intercooling and advantages of Multistage compression.	**05**
02	**Gas Turbines** Classification, Application, open cycle and closed cycle gas turbine. Calculation of thermal efficiency. Methods for improvements of thermal efficiency of gas turbine plants (Numericals only on calculating thermal efficiency and work ratio).	**05**
03	**I.C. Engines** Classification, components of engines, 2 stroke and 4 stroke engine, SI & CI engine. Study of simple carburetor, fuel injection systems, ignition system, combustion process in SI and CI engines. Cooling and lubrication systems. Testing &Performance of IC engines and Heat Balance Sheet.	**08**
04	**Heat Transfer** Modes of heat transfer, Fouriers Law of heat conduction Newtons law of cooling. Conduction: thermal conductivity, heat transfer coefficient(convective and overall), 1D steady state heat conduction through plane wall, composite wall, hollow cylinder and hollow sphere. Convection: Free and Forced convection. Radiation: Stefan Boltzman's Law, Kirchoff's Law, Weins law. Heat Exchangers: classification, LMTD (Numericals only on 1D conduction and calculation of LMTD).	**08**
05	**Refrigeration** Applications of refrigeration, terminology, Bell Colemann cycle, Vapour compression refrigeration cycle. Calculations for COP, power capacity and mass flow rate. Vapour Absorption System (Ammonia water system) (Numericals only on VCR).	**05**
06.	**Air conditioning** Properties of moist air, basic psychometric processes. Introduction to air conditioning, applications, comfort air conditioning, summer, winter and year round air conditioning system.	**05**

Term Work

Term work shall consist of at least one assignment from each module of syllabus, minimum 06 experiments based on topics from syllabus to be conducted and presented with inferences and a detailed report based on Industrial visit to a Thermal power/cold storage/air conditioning plant.

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

- Laboratory work (Experiment/ programs and journal): **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. *Thermal Engineering*, Mahesh Rathore, Tata Mc Graw Hill
2. *Thermal Engineering*, R. K. Rajput, Laxmi Publication
3. *Thermal Engineering*, Ballaney, Khanna Publication
4. *A Course in Thermal Engineering*, Domkundwar, Kothoraman and Khaju.

Course Code	Course/Subject Name	Credits
PEL501	**Business Communication & Ethics[#]**	**2**

[#] Common with All Engineering Programs

Pre-requisite: FEC206 Communication Skills

Objectives

1. To inculcate in students professional and ethical attitude, effective communication skills, teamwork, skills, multidisciplinary approach and an ability to understand engineer's social responsibilities.
2. To provide students with an academic environment, where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career.
3. To inculcate professional ethics and codes of professional practice
4. To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Outcomes: A learner will be able to …

1. communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
2. Participate and succeed in Campus placements and competitive examinations like GATE, CET.
3. Possess entrepreneurial approach and ability for life-long learning.
4. Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module	Unit No.	Topics	Hrs
1.0	**1.0**	**Report Writing**	**07**
	1.1	Objectives of report writing	
	1.2	Language and Style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project and survey based	
2.0	**2.0**	**Technical Proposals**	**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.0	**3.0**	**Introduction to Interpersonal Skills**	**07**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team Buliding	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	
4.0	**4.0**	**Meetings and Documentation**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	

5.0	**5.0**	**Introduction to Corporate Ethics and etiquettes**	**02**
	5.1	Business Meeting etiquettes, Interview etiquettes, Professional and work etiquettes, Social skills	
	5.2	Greetings and Art of Conversation	
	5.3	Dressing and Grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.0	**6.0**	**Employment Skills**	**06**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
		Total	**26**

List of Assignments

1. Report Writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal)
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (Case study, Role play)
7. Cover Letter and Resume
8. Printout of the PowerPoint presentation

Term Work

Term work shall consist of all assignments from the list.

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

- Assignments **:** **20 marks**
- Project Report Presentation**:** **15 marks**
- Group Discussion**:** **10 marks**
- Attendance **:** **05 marks**

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

References

1. Fred Luthans, "*Organizational Behavior"* , Mc Graw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business"* , Mc Graw Hill, edition
3. Huckin and Olsen, "*Technical Writing and Professional Communication"*, McG. Hill
4. Wallace and Masters, "*Personal Development for Life and Work"* , Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication"* , Mc Graw Hill, edition
6. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing",*
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill. Lehman,
8. Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
9. Bell . Smith, "Management Communication" Wiley India Edition,3rd edition.
10. Dr. K. Alex ,"Soft Skills", S Chand and Company
11. Dr.KAlex,"SoftSkills",S Chand and Company
12. R.Subramaniam, "Professional Ethics" Oxford University Press 2013.

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.	**06**

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.