AC 7/6/2014
Item No. – 4.34 & 4.35

UNIVERSITY OF MUMBAI

Bachelor of Engineering

Production Engineering

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

Revised course (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	125
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**	**50**	**850**

* Theory for entire class to be conducted

Common with all branches

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**

B. E. (Production) Sem.-VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEP701	Industrial Training and Project	--	5*8=40	--	20	20

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)	Term Work	Pract./ Oral	Total
		Presentation		Avg.					
		Stage 1	Stage 2						
PEP701	Industrial Training and Project	50	50	50	--	--	100	50	200
Total		**--**	**--**	**50**	**--**	**--**	**100**	**50**	**200**

* Industrial training and Project report should be of 24 weeks. (8hours a day and 5days a week translates into 40 contact hours per week)

Workload: Contact teacher hours for project guidance – One hour per student per week.

B. E. (Production) Sem.-VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
PEC801	Automation and Control Engineering	4	2	4	1	5
PEC802	Computer Aided Manufacturing	4	2	4	1	5
PEC803	Engineering Economics, Finance, Accounting and Costing	4	--	4	--	4
PEC804	Total Quality Strategy	4	2	4	1	5
PEC805	Industrial relations and Human Resource Management	4	--	4	--	4
PEE801X	Elective-I	3	2	3	1	4
	TOTAL	**23**	**08**	**23**	**4**	**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.					
PEC801	Automation and Control Engineering	20	20	20	80	03	25	25	150
PEC802	Computer Aided Manufacturing	20	20	20	80	03	25	25	150
PEC803	Engineering Economics, Finance, Accounting and Costing	20	20	20	80	03	--	--	100
PEC804	Total Quality Strategy	20	20	20	80	03	25	25*	125
PEC805	Industrial Relations and Human Resource Management	20	20	20	80	03	--	---	100
PEE801X	Elective-I	20	20	20	80	03	25	--	125
Total		**--**	**--**	**120**	**480**	**--**	**100**	**50**	**750**

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

List of Electives

Course codes	Course Name	Course codes	Course Name
PEE8011	Sales and Marketing Management	PEE8016	Mechatronics
PEE8012	Logistics and Supply Chain Management	PEE8017	Industrial Robotics
PEE8013	Plastics Engineering	PEE8018	Product Design and Development
PEE8014	Entrepreneurship Development	PEE8019	Sustainable Engineering
PEE8015	World Class Manufacturing	PEE80110	Maintenance Engineering

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 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 process.

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 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.
4. To make the students develop the capacity of critical judgment and be an independent thinker.

Outcomes: Learner will be able to**…**

1. Understand and apply the principles of effective teamwork.
2. Conduct experiments as well as analyze and interpret data.
3. Identify, formulate, and solve engineering problems.

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.	**10**
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).	**10**
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 acquaint 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 appraise 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 chart.
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 management of various resources.
2. To acquaint with simulation tools for optimization for various resources

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 die.

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 equipment's 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 flow, 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.	**11**
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 of 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.

Course Code	Course/Subject Name	Credits
PEP701	**Industrial Training and Project**	**20**

Objectives

1. To help to correlate the lessons learnt in theory and actual practices followed in the industries.
2. To expose to an industrial environment.
3. To get tuned to work under the atmosphere of factory discipline.
4. To make aware of the psychology of the workers, their habits, attitudes and to prepare them to approach the problems, considering the practices followed in an industry.
5. To make appreciate the need for a co-ordinated effort of various persons at different levels in different departments for achieving the set goals and targets.

Outcomes: Learner will be able to…

1. Get familiarized with various technological trends, approaches and applications along with managerial exposure.
2. Appreciate and realize the size and scale of operations in Industry.
3. Get an opportunity to apply their knowledge in problem solving and eventually develop that skill.
4. Demonstrate understanding of relevant application oriented subjects in a better prospective.
5. Demonstrate understanding of various constraints of time and cost, within which goods are produced and services rendered in a specified quantum.
6. Describe the scope, functions and job responsibilities in various departments of an organization.
7. Develop a positive attitude, which will bring in a visible change in their approach while dealing with technical and interpersonal issues.

Guidelines for Evaluation/Assessment

The total duration for each presentation shall be maximum 30 minutes, inclusive of 20 minutes for presentation and 10 minutes for discussion. 50 marks each for stage I and stage II to be awarded based on the points furnished below and as per the discretion of the internal project guide.

1. Content of the presentation.
2. Presentation skill.
3. Interest taken, personal involvement and contribution.
4. Headway/progress made in the project execution.

Evaluation/Assessment of the Term Work

1. Introduction, Acknowledgements, references. 2. Company background/ activities. 3. Training areas / Training details.	10
4. Synopsis / Abstract of the Project.	10
5. General presentation, neatness and accuracy of the data furnished.	15
6. Technical contents of the report with data / observations, graphs, drawings, etc	25
7. Quality of work carried out and details furnished based on personal Observations/involvement.	30
8. Result/ Conclusion.	10
Total -	100

Note: Report shall be prepared using University of Mumbai approved Guidelines.

Course Code	Course/Subject Name	Credits
PEC801	**Automation and Control Engineering**	**4+1**

Objectives

1. To acquaint with basic concepts of industrial automation involving pneumatic and hydraulic controls.
2. To familiarize with the elements of electro-pneumatic interface with control systems.
3. To learn about the application of microprocessors and microcontrollers.

Outcomes: Learner will be able to…

1. Apply automation techniques to manufacturing set-ups.
2. Design and develop pneumatic and hydraulic control circuits of medium complexity.
3. Illustrate the use of PLC in control systems.
4. Model the system and check the stability of a mechanical system.

Modules	Details	Hrs.
01	**Automation** Definition; Automation in production systems; Automation principles and strategies; Basic elements of an automated system; Advanced automation functions; Levels of automation; Types of automation; Benefits and Impact of Automation in Manufacturing and Process Industries. Architecture of Industrial Automation Systems.	**06**
02	**Pneumatic control systems** Overview of different types of valves and Actuators in Pneumatics, their applications and their ISO symbols. Design of Pneumatic circuits using Cascade method and Shift register method (up to 3 cylinders). Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves with and without grouping. Design of Pneumatic circuits using PLC Control (ladder programming only and up to 3 cylinders) with applications of Timers and Counters and concept of Flag and latching.	**11**
03	**Hydraulic control systems** Overview of different types of valves, Actuators and Accumulators used in Oil hydraulic circuits, their applications and their ISO symbols. Basic hydraulic circuits involving linear and rotary actuators (No sequential circuits). Fundamental concepts of digital and servo hydraulic controls. Comparison between proportional, digital and servo hydraulic control systems.	**07**
04	**Digital logic:** Number systems; Logic Gates; Boolean Algebra; Simplification of Boolean equations using Karnaugh Maps. **Microprocessors and Microcontrollers (Only basic understanding and applications)** Concept of Microprocessor based control and its application; Parts of a Microprocessor system with block diagram of the general form of a microprocessor system; Data bus, Address bus and Control Bus; General internal Architecture of a Microprocessor; Functions of constituent parts such as ALU, Various Registers and the Control unit. Difference between a Microprocessor and a Microcontroller. General Block diagram of Microcontroller.	**11**

05	**Sensors and Transducers** Fundamentals of displacement, position and Proximity Sensors; Velocity and Motion Sensors; Force and Fluid Pressure Sensors; Liquid level and Flow sensors; Temperature and light Sensors; Control of stepper motors.	**02**
06	**Fundamentals of Control System** Control system concepts, classification of control systems, mathematical representation of system equations, response characteristics of components and systems through classical solution. Analog computer and Laplace transformation, Frequency response analysis, polar plots, Testing of System's stability using Routh's criteria, Bode plots, Nyquist plot and Root locus method of analysis.	**11**

List of Experiments

1. Experiments based on modules 2 & 3 on fluid simulation kit.
2. Pneumatic and electro pneumatic sequencing circuits simulation on simulation software.
3. Introduction to mathematical programming softwares like Matlab or Scilab. Introduction to the GUI working; basic codes; introduction to the graphing tools; Implementation of bode plot and root locus.

Term Work

Term work shall consist of at least six experiments based on sr. no. 1 and 2 from list of experiments, minimum two exercises based on sr. no.3 from list of experiments and at least one assignment from each module of 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.

Practical/Oral examination

1. Practical examination shall be conducted based on the experiments conducted as part of term work. Examination shall be based on simulations experiment.
2. Examiners are expected to evaluate learners' skill of programming and machining 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. *Automation, Production Systems, and Computer-integrated Manufacturing (3rd Edition),* by Mikell P. Groover, PHI Learning Private Limited, New Delhi.
2. *Pneumatic Controls,* by Joji P., Wiley India Pvt. Ltd.
3. *Principles Of Control Systems,* by U.A.Bakshi, V.U.Bakshi, Technical Publications Pune .
4. *Pneumatics Basic Level*, by Peter Croser, Frank Ebel, Festo Didactic GmbH & Co. Germany
5. *Electropneumatics Basic Level,* by G. Prede, D. Scholz, Festo Didactic GmbH & Co. Germany.
6. *Programmable logic controllers Basic Level*, by R. Bliesener, F. Ebel, C. Löffler, B. Plagemann, H. Regber, E. V. Terzi, A. Winter, Festo Didactic GmbH & Co. Germany.
7. *Vickers Industrial Hydraulics Manual (3rd Edition),* Vickers Inc.; Maumee, OH. *Hydraulic and Pneumatic Controls (2nd Edition),* by R. Srinivasan, Vijay Nicole Imprints Pvt. Ltd. Chennai.
8. *Introduction to Hydraulics and Pneumatics,* by S.Ilango and V. Soundararajan, PHI Learning Pvt. Ltd. New Delhi.

Course Code	Course/Subject Name	Credits
PEC802	**Computer Aided Manufacturing**	**4+1**

Objectives

1. To familiarize with concepts of computer aided manufacturing and its significance.
2. To familiarize with interfacing of drive systems with the machines.

Outcomes: Learner will be able to..

1. Develop expertise in computer-aided manufacturing.
2. Illustrate basic concepts of control systems.
3. Write /Select the appropriate code for performing particular tasks in a CNC.

Module	Details	Hrs.
01	**Introduction** Elements of CAM system, Computer Numerical control of Machine Tools, Fundamental elements of CNC, Benefits of CNC, Computer control concepts, Data processing units & Binary calculation.	**05**
02	**Rapid prototyping** Introduction to rapid Prototyping and rapid tooling.	**04**
03	**Basics of control systems** Motion controller, Interpolation-Linear & Circular, Positioning & Contouring control loops, Incremental & Absolute system, DNC & CNC systems and Adaptive control system. **CNC Hardware Basics** CNC drives, Spindle design, Actuation and Feedback devices	**06**
04	**CNC Tooling** Turning tools, Milling tools, Tool pre setter, ATC, work holding devices and Cutting process parameters.	**05**
05	**CNC Programming** Introduction to CNC Lathe & Milling, Touch probe system, Tool length, nose radius & Diameter compensation, Turning & Machining centre programming, CNC part programming using ISO controllers, Canned cycles, Looping Jumping Subroutines Macros, Parametric programming, Computer aided part programming using APT and Post processing.	**16**
06.	**CIM** Computer applications in manufacturing, Automation and Integrated Production management systems. Automated Material handling systems, Conveyors, AVG, AS/RS, Automated inspection procedure, Distributed Numerical control & Benefits of CIM and implementation & computer aided shop floor control system. Concept of "Ghost" factory.	**12**

Term Work

Term work shall consist of minimum 06 experiments based on topics from syllabus to be conducted and presented with inferences and at least one assignment from each module of 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.

Practical/Oral examination

1. Practical examination shall be conducted based on the experiments conducted as part of term work. Examination shall be based on tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers.
2. Examiners are expected to evaluate learners' skill of programming 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. *Mastering CAD/CAM*, Ibrahim Zeid
2. *CAD/CAM* , P.N. Rao
3. *Computer aided design and manufacturing*, Mikel.P.Groover
4. *CNC & CAM* , G.E.Thyer.
5. *Numerical Control and computer aided Manufacturing*, T.K.Kundra, R.N.Rao, and N.K.Durai.
6. *CAD/CAM/CIM* , P.Radha Krishnan and S.Subramanyam.
7. *CAD/CAM Hand Book*, Machever c and Baluth R.E.
8. *Programming for Numerical control of machines*: Roberts A.D and Prentice R.C.
9. *Computer Integrated Manufacturing*, Alan Weatherall.
10. *CAD/CAM systems, Planning and Implementation*: Charles S Knox.
11. *CAD/CAM Handbook*, Erich Teicholz.

Course Code	Course/Subject Name	Credits
PEC803	**Engineering Economics, Finance, Accounting and Costing**	**4**

Objectives

1. To acquaint with the concepts of Micro and Macro Economics.
2. To comprehend the need, definition, functions and economic significance of financial institutions and markets.
3. To familiarize with the concept of Fiscal and Monetary Policy.
4. To acquaint with financial statements and Annual Reports of industries.
5. To familiarize the students with cost records / statements.

Outcomes: Learner will be able to…

1. Correlate various micro and macro economic variables.
2. Illustrate Economic policies and their implications.
3. Get familiarized with the roles played by various financial institutions/banks.
4. Get exposure to various business strategies.
5. Get familiarized with Accounting and costing practices.

Module	Details	Hrs.
01	**Introduction** Definition of Economy, Central problems of an economy: what, how and for whom to produce; concepts of production possibility frontier and opportunity cost. Economics, its scope and importance. Introduction to Micro and Macro economics and their comparison.	**04**
02	**Micro Economics** 2.1 Consumer's Behaviour: meaning of utility, marginal utility and law of diminishing marginal utility. 2.2 Conditions of consumer's equilibrium using marginal utility analysis: Concept of ordinal utility, law of demand and relation between law of demand & law of diminishing marginal utility. 2.3 Producer's Behaviour: law of supply, variation in supply, Types of elasticity of supply. Types of Market: perfect competition, pure competition, Monopoly and Multi-plant monopoly.	**05**
03	**Macro Economics** 3.1 Concept of National Income: Circular flow of income, Distinction between Gross and Net National Income. Different Methods of Measuring National Income , Definition of Money, Functions of Money, Value of Money and Different concepts of Money. 3.2 Economic Policy: Monetary, Income and Fiscal Policies. 3.3 Functions of Central Bank, Functions of Commercial Banks credit Creation, Credit Control Methods, Theory of Inflation, Concepts of Inflation, Effects of Inflation and Anti-inflationary policies.	**05**
04	**Financial Environment of Business:** Financial Management-Sources of finance-long term and short term finance **Capital Markets** 4.1 Primary Market: Basics of capital market mechanism and instruments. Secondary Market: Basics of stock exchange and their role, Role of SEBI, Role of FIIs, MFs and Investment Bankers. 4.2 Money Markets: Basics of Money Market Mechanism, instruments, and institutions.	**06**

05	**Management Accounting:** Understanding of Financial Statements (Overview), Interpreting Financial Statements (overview). **Accounting Mechanics, Process and system:** Introducing Book Keeping and Record Maintenance, The concept of Double Entry and fundamental principles, Journal, Ledger, Trial Balance and Final Accounts. Financial Analysis, Ratio Analysis and comparative balance sheet.	**12**
06	**Cost and Management Accounting** Introduction to cost, Types of cost, Treatment of Overheads, Unit Costing (Cost Sheet), Joint Product Costing, Process Costing, Marginal Costing, Cost Volume Profit Analysis and Decision Making. Budgetary Controls, Standard Costing, concept and Importance of Depreciation and Methods of Depreciation.	**16**

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. *Managerial and Cost Accounting*, Larry M. Walther , Christopher J. Skousen
2. *Strategic Financial Management*, Robert Alan Hill
3. *Basics of Accounting & Information Processing The Accounting Cycle*, Larry M. Walther , Christopher J. Skousen
4. *Introduction to Managerial Accounting*, Larry M. Walther , Christopher J. Skousen
5. *Managerial and Cost Accounting*, Larry M. Walther , Christopher J. Skousen
6. *Essentials of Microeconomics*, Krister Ahlersten
7. *Essentials of Macroeconomics*, Peter Jochumzen
8. *Banking: An Introduction*, Dr AP Faure, Rhodes University
9. *Financial System: An Introduction*, Dr AP Faure, Rhodes University
10. *Central Banking & Monetary Policy: An Introduction*, Dr AP Faure, Rhodes University.

Course Code	Course/Subject Name	Credits
PEC804	**Total Quality Strategy**	**4+1**

Objectives

1. To acquaint with key features of the TQS philosophy.
2. To appraise the contribution rendered by quality gurus.
3. To familiarize with various quality tools and their uses in solving the problems.
4. To impress upon the ongoing global trend of quality focus to customer delight.

Outcomes: Learner will be able to…

1. Identify and use proper quality tools in various manufacturing /service functions.
2. Integrate quality approaches for productivity improvement.
3. Realize the compromise approach of quality and cost.
4. Realize that quality should not be inspected, but should be inbuilt into the system.

Module	Details	Hrs.
01	**Introduction** 1.1 Evolution of Quality, Definition of Quality, Dimensions of Quality, Quality Planning, Principles of TQM, Quality in Manufacturing and Service Systems, Economic Issues, Quality and Market Share, Barriers to TQM Implementation. 1.2 Cost of quality: prevention, appraisal & failure costs and Hidden cost of quality.	**06**
02	**Strategic planning for quality** 2.1 Need for quality policies & objectives with examples. 2.2 Leadership concepts, Importance of Top Management commitment, quality council and strategic planning. **Quality improvement** 2.3 Juran's trilogy, management of controllable defects, operator controllable defects, sporadic and chronic problems of quality. 2.4 Bench Marking: Introduction, definition and its significance. Collection of data for bench marking and its use.	**09**
03	**Customer relation and satisfaction:** 3.1 Origin of consumerism - Product knowledge, definition and types of customers, their importance, Customer perception and quality expectations. 3.2 Quality feedback and redressal. 3.3 Definition and principles of reliability, reliability and product life cycle (boat curve/bath tub curve), trade-off between reliability, maintainability and availability.	**06**
04	**Supplier Relations** 4.1Treating Supplier as a partner, Principle and elements of Partnering. 4.2 Selection of supplier, Performance measurement & rating of supplier 4.3 Push-Pull view of supply chain and Cycle view of supply chain management.	**05**

05	**Quality / Productivity Improvement Tools** 5.1 Process Data Collection & presentation – Bar Chart, Histogram and Run Charts. 5.2 Process Variability – variables & Process Variation (Measures of accuracy & Centering, precision or spread, normal distribution and sampling averages). 5.3 Process Control by Variable – using X bar and R Chart and control charts for standard deviation. 5.4 Process Control by Attribute - for number of defectives or non-conforming units - **np**-charts, **p**-charts, **c**-charts and **u**-charts 5.5 Process capability, OC curve, acceptance sampling AQL, LTPD, AOQL, producers and consumers risk (Single & Double sampling plan only). (Note: Emphasize the explanation with Numerical problems).	**11**
06.	**Quality Systems** 6.1 Quality standards a. The ISO9001:2000 Quality Management System Standard b. The ISO 14001:2004 Environmental Management System Standard c. ISO 27001:2005 Information Security Management System d. ISO/TS 16949:2002 for Automobile Industry e. Internal audit, surveillance audit, maintaining of certification. 6.2 PDCA cycle, Problem solving tools (old & new), JIT, Importance of 6sigma, DMAIC approach, SIPOC Process and Sample Calculation of sigma level. 6.3 Approach to world class manufacturing (Toyota production system, Lean manufacturing, Zero defect supply concept), Quality Function Deployment (QFD), Failure Mode Effect Analysis (FMEA), Introduction to DoE, Shainin concepts of Quality and Customers / Suppliers voice 6.4 Productivity improvement techniques -5S, POKAYOKE, SMED, Kaizen and concurrent engineering,	**11**

Term Work

Term work shall consist of at least one assignment from each module of syllabus and Seminar / Case study presentation with report in a group of not more than 4 students.

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

- Seminar / Case study 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.

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. *Quality planning and analysis*, J M Juran, FM Gryana, TMH
2. *Total Quality Management*, D. H. BesterField et al. prentice hall.
2. *Quality is free*, Philip B Crossbly, Mentor/ new American library.
3. *What is Total Quality Control? The Japanese way*, Ishikawa k, PH.
4. *Total Quality Control*, Armand V Feigenbaum.
5. *TQM in new product manufacturing*, HG Menon; TMH.
6. *Managing for total quality*, N. Logothetis / prentice hall
7. *Total quality management*, Dr.Uday K.Haldar/Dhanpatrai & co.
8. *Total quality management*, Dr.K.C.Aurora/S.K.Kataria & sons.
9. *Statistical Process Control*, John S. Oakland, Butterworth-Heinemann.

Course Code	Course/Subject Name	Credits
PEC805	**Industrial Relations and Human Resource Management**	**4**

Objectives

1. To get an **e**xposure to aspects pertaining to human resource and its relevance in industry.
2. To focus on the behavioral aspects and industrial relations.
3. To get exposure to management of Human resources.

Outcomes: Learner will be able to…

1. Appreciate human resource as the most vital resource of an organization.
2. Develop skills in identifying, planning, and deploying of man power.
3. Develop inter personal and communication skills.
4. Develop skills in identifying training needs of employs at different levels.

Module	Details	Hrs.
01	**Evolution and Developments of thought** Evolution of managements thought, behavioral, contingency and Contemporary management approach. **Organization structure** Definition, need, types of organizational responsibility, authority, accountability, delegation and span of control.	**08**
02	**Decision Making** Types of decision, steps in rational decision making. **Functions of personnel Management** Managerial and operative functions.	**06**
03	**Communication** Significance of communication, Principles of effective communication and Barriers of communication. **Leaderships** Different styles of leadership and their suitability, Empowering employees and Manager as a leader.	**10**
04	**Human Behavior** Perception, attitude, Groups, Types of groups, Groups behavior, Morale and Job satisfaction. **Motivation** Theories of Motivation, Job design, Job enlargement and enrichment, Difference between manipulation & motivation and Performance appraisals.	**06**
05	**Human resource development** 5.1 Human resource planning, Job description, Job analysis and job evaluation, Recruitment and selection procedure. 5.2 Training and Development: Concepts and difference between training and development, Identification of training needs at different levels, Methods, Steps and Types of training. 5.3 Promotion: Basis for promotion and their merits and demerits. 5.4 Retaining of human resource: 5.6 Safety, steps in safety programme, Occupational hazards, and Accident prevention..	**12**

06	**Compensation and salary Administration:** 6.1 Factory act, Industrial dispute act, Salary and wage fixation and Workman's compensation act. 6.2 Employee grievances, Machinery for addressing grievances, Collective bargaining, Industrial relations, Trade unions and managing Conflicts.	**06**

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. *Personnel Management and Human Resources,* C.S. Venkataratnam, B,K, Srivastava
2. *Principles of Management,* P.C. Tripathi, P.N. Reddy
3. *Industrial and Business Management,* Martand T. Teslang
4. *Organization Behavior, Text and cases,* Uma Sekram
5. *Oraganizational Behavior,* F. Luthans
6. *Personnel Management,* C.B. Memoria.
7. *Factory Administration and Management,* A.S.Deshpande.
8. *The Change in world of the Executive,* Peter Drucker.
9. *In search of excellence,* Tom Peter and R, H.Waterman Harper.

Course Code	Course/Subject Name	Credits
PEE8011	**Sales and Marketing Management**	**4**

Objectives

1. To make conversant with various principles and strategies.
2. To acquaint with methodology for product pricing policies and distribution channels.
3. To make aware of promotional policies, advertising strategies and principles of market research.

Outcomes: Learner will be able to…

1. Illustrate various selling strategies, pricing strategies and methodology of product positioning.
2. Get exposure about customer behavior and their implications in marketing.
3. Develop capability to assess, analyze and measure sales and marketing performance.
4. Get exposure to promotional policies and importance of advertising.
5. Evaluate effectiveness of advertising.

Module	Details	Hrs.
01	Definition of marketing, Understanding marketing, Sales, Company orientations, Journey from sales to marketing, New economy, Environmental forces, Marketing task, Marketing concepts and tools, Major drivers of the economy, Changing of business practices, Changing of marketing practices, E- business	**05**
02	Customer value and satisfaction, Organizational culture, Attracting and retaining customers, Cost of lost customer, Total customer satisfaction, Customer relationship management, Survey of customer needs, Consumers, Organizational and Government buyers.	**05**
03	Differentiation, Segmenting, Targeting, Positioning, Marketing decision support system, Product life cycle, Portfolio management, Customer perception of product features, New product development.	**07**
04	Competition, Market research, Management strategies, 4Ps of product marketing and 7Ps of service marketing, Product policies, Product brands, Services offering, Pricing, Customer perceived value, Distribution channels, Retailing, Marketing Plan and implementation, Market testing.	**08**
05	Marketing Organization, Selection of marketing staff, Specialized Training, Role of a salesman, Routine management, Salaries and incentives, Marketing intelligence, Marketing performance.	**05**
06	Customer focus, Advertising, Sales promotion, Motivation research, Consumer behavior, Buying decision process, Competitive strategies, Audit of customer satisfaction	**06**

Term Work

Term work shall consist of at least one assignment from each module from syllabus and at least two (2) seminars / case study on the modules / trending scenario.

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

- Seminar / Case study Presentation & report **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. *Marketing Management: A South Asian Perspective*, Philip Kotler , Abraham. Koshy , Kevin Lane Keller , Mithileswar Jha.
2. *Marketing, A Managerial Introduction*, J. C. Gandhi.
3. *Principles and Practice of Marketing in India*, C. B. Mamoria, Raman Lal Joshi.
4. *Principles of Marketing and Salesmanship*, J. C. Sinha.
5. *Marketing management*, V. S. Ramaswamy, S. Namakumari.
6. *Indian Cases in Marketing*, M. D. Kakade.
7. *Advertising: Art and Ideas*, Dr. G. M. Rege.
8. *Advertising*, Chakaraborty, Page 17 of 30.

Course Code	Course/Subject Name	Credits
PEE8012	**Logistics and Supply Chain Management**	**3+1**

Objectives

1. To develop an understanding of key drivers of supply chain performance and their inter-relationships with strategy.
2. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management
3. To acquaint with design problems and develop an understanding of information technology in supply chain optimization.
4. To acquaint with the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Outcomes: Learner will be able to…

1. Know functions of supply chain management and its processes.
2. Study the flows of material, information and funds in a unified manner.
3. Evaluate the performance of supply chain management.
4. Illustrate complexity involved in coordination of inter-firm and intra-firm in implementing programs

Module	Details	Hrs.
01	**Building a Strategic Frame Work to Analyse Supply Chains** Supply chain stages and decision phases, Process view of supply chain: Supply chain flows, Examples of supply chains, Competitive and supply chain strategies, Achieving strategic fit: Expanding strategic scope, Drivers of supply chain performance. Framework for structuring drivers: inventory, transportation facilities, information obstacles to achieving fit.	**04**
02	**Designing the Supply Chain Network** Distribution Networking: Role, Design, Supply chain network (SCN): Role, Factors, framework for design decisions.	**05**
03	**Materials Management** Scope, Importance, Classification of materials, Procurement, Purchasing policies, Vendor development and evaluation. Inventory control systems of stock replenishment, Cost elements, EOQ and its derivative modules.	**05**
04	**Dimensions of Logistics** Introduction: A macro and Micro Dimensions, Logistics interfaces with other areas, Approach to analyzing logistics system, Logistics and systems analyzing: Techniques of logistics system analysis, factors affecting the cost and Importance of logistics.	**06**
05	**Warehouse and Transport Management** Concept of strategic storage, Warehouse functionality, Warehouse operating principles, Developing warehouse resources, Material handling and packaging in warehouses, Transportation Management, Transport functionality and principles, Transport infrastructure, transport economics and Pricing. Transport decision making	**06**

06	**IT in Supply Chain** IT framework, Customer Relationship Management(CRM),internal Supply chain management, Supplier Relationship Management (SRM),Transaction management, **Coordination in A Supply Chain** Lack of supply chain coordination and the Bullwhip effect, Obstacle to coordination, Managerial levers, Building partnerships and trust. **Emerging Trends and Issues** Vendor managed inventory-3PL-4PL, Reverse logistics: Reasons, Role, Activities; RFID systems: Components, Applications, Implementation; Lean supply chain, Implementation of Six Sigma in supply chain, Green supply chain.	**10**

Term Work

Term work shall consist of at least one assignment from each module from syllabus and at least two (2) seminars / case study on the modules / trending scenario.
The distribution of marks for term work shall be as follows:

- Seminar / Case study Presentation & report **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. *Supply Chain Management Strategy, Planning, and operations*, Sunil Chopra and Peter Meindl.
2. *Materials Management & Purchasing*, Ammer D.S. Taraporawala.
3. *Designing & Managing Supply chain*, David Simchi Levi, Philip Kaminsky & Edith Smichi Levi.
4. *Supply Chain Redesign: Transforming Supply Chains into Integrated Value Systems*, Robert B Handfield, Ernest L Nicholas.
5. *The Management of Business Logistics: A Supply Chain Perspective*, Coyle, Bardi, Langley.

Course Code	Course/Subject Name	Credits
PEE8013	**Plastics Engineering**	**3+1**

Objectives

1. To appraise about the vast potential of plastics materials in domestic engineering and specialty application areas.
2. To introduce to various processing techniques.
3. To familiarize with design of moulds and dies.

Outcomes: Learner will be able to…

1. Get an exposure to the world of plastics
2. Develop competency in exploring possibilities of replacing conventional materials.
3. Acquire competency in designing various tools for plastics processing.

Module	Details	Hrs.
01	**Materials** Brief introduction to plastics materials. Introduction to plastics blends, alloys and composites. Principles of recycling of plastics and waste management.	**02**
02	**Processing Techniques** 2.1 **Injection Moulding** Moulding materials, moulding cycle-phases, and significance. Moulding Machinery: types, constructional and design features, plasticizing screw, injection and clamping units, Technical specifications and selection. Processing Techniques: Process parameters and their influence on product quality, trouble shooting. 2.2 **Extrusion Process** Constructional and design features of extrusion machinery plasticizing screw. Technical specification and selection. Extrusion lines for pipes, Films (monolayer and multilayer, blown and cast films), sheets, Extrusion coating, monofilaments, box strapping, cables/wires and profiles. [Coverage for the above should include materials, plant layouts, in line equipment, extrusion techniques, process parameter and their influence on extruded products and trouble shooting). 2.3 **Blow Moulding** Materials for blow moulding application, Types of Machinery, technical specifications and selection. (Extrusion Blow Moulding, Injection blow moulding and stretch Blow moulding). Processing Techniques: Process parameters and their influence on product quality, trouble shooting Comparison between types of Blow Moulding Processes.	**10**
03	**Auxillary equipment for plastics processing** Hopper dryers, Dececant dryers, Granulators, Mould temperature controllers, Proportionating devices, chilling units, automatic material conveying systems. **Other Process**: Brief coverage of the following processes with relevant details like machinery, materials, processing techniques and applications. Thermoset Mouldings, Thermoforming, Rotational Moulding, calendaring, fabrication and decorating with plastics. **FRP Techniques**: Raw materials and ancillaries used techniques like Hand lay-up, spray up and filament winding processes, applications.	**05**

04	**Product designing with plastics** Mechanical behaviour of plastics, creep data and its significance in designing. Product designing tips for designing articles to be manufactured by injection moulding, blow Moulding and Extrusion Moulding	**02**
05	**Design of Moulds** 5.1 Compression and transfer moulds: General arrangement of compression moulds-flash, semi positive and positive versions. General arrangement of transfer moulds-moulds for integral pot and auxillary transfer. 5.2 Injection Moulds: General arrangement of two plate moulds. Design of mould components, design of feedings, cooling and ejection systems, three plate moulds, Designing for moulds for articles with undercuts-split moulds and moulds with side cores actuation techniques, moulds for internally threaded articles, fully automatic moulds, mould standardization and innovative mould components. 5.3 Hot runner systems: General arrangement, design of manifold blocks, flow ways and nozzles, advantages and limitations.	**11**
06	**Blow Moulds:** General arrangement and mould components, design of neck and base pinch offs and flash pockets, Venting of moulds, selection of parting lines. **Extrusion Dies**: Design of extrusion dies for pipes, films, sheets, cables and profiles. **Mould Materials of Construction**: Characteristics, Tool steels and alloys, non-ferrous materials.	**06**

List of Design Exercises

1) Design and drawing of one injection mould.
2) Design and drawing of one extrusion die.

Term Work

Term work shall consist of at least two assignments from each module from syllabus, design exercises as mentioned in above list and at least one presentation based on module 2nd and 3rd from syllabus.

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

- Design Exercises including drawing: **10** marks
- Assignments/Presentation: **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. *Moulding of Plastics*, Bickales.
2. *Design of Extrusion dies,* M. V. Joshi.
3. *Injection of Mould Design,* R. G. W. Pyre.
4. *Plastic Materials*, Brydson.
5. Extrusion Technology – Allen Griff.
6. *Practical guide to Blow Moulding*, Lee.
7. *Injection Moulding: Theory and Practice*, Rubin.
8. *Handbook of Composite fabrication,* Akovali.
9. *Plastic product materials and process selection Handbook*, Rosato.

Course Code	Course/Subject Name	Credits
PEE8014	**Entrepreneurship Development**	**3+1**

Objectives

1. To appraise various aspects pertaining to entrepreneurship.
2. To instill in the minds of the candidates the significance of entrepreneurship and its role in industrial / economic development.
3. To make conversant with the systematic steps involved in identifying opportunities and initiating an enterprise.
4. To gain knowledge about finance, accounting and support organization.
5. To impart knowledge on various management issues and familiarize with various regulatory acts.
6. To serve as a knowledge base for aspiring entrepreneurs.

Outcomes: Learner will be able to..

1. Acquire entrepreneurial competency.
2. Develop skills in carrying out market research, identifying business opportunities and preparing feasibility in projects reports.
3. Get motivated to venture entrepreneurship as earlier option
4. Acquire requisite knowledge in setting up business enterprise from the start to accomplishment of the projects.
5. Gain competency in diversifying and enhancing existing business plans.

Module	Details	Hrs.
01	**Entrepreneurship Concepts:** Concepts of entrepreneurship, Characteristics of successful entrepreneurs, Functions of entrepreneurs, Types of entrepreneurs, Distinction between entrepreneur and manager, Growth of entrepreneurship in India and role of entrepreneurship in economic development **Types of entrepreneurship:** Women entrepreneurship, Rural entrepreneurship, Tourism entrepreneurship, Agripreneurship, social entrepreneurship & family business – Factors affecting entrepreneurship growth.	**04**
02	**Entrepreneurship Development:** Entrepreneurial motivation: Theories of entrepreneurial motivation, motivating factors, motivational process, motivational behavior, creativity, self efficiency, Risk taking, leadership, communication, decision making, major entrepreneurial competencies and development. Entrepreneurship development programmes: Objectives, contents and evaluation. Small Enterprises: Micro and macro units, scope of micro and small enterprises and their role in economic development – problems of micro and small enterprises – promotional packages.	**04**
03	**Opportunity / Product Identification:** Business opportunities in various sectors, identification of business. Opportunity- idea generation and opportunity selection. Steps in setting up of small business enterprises. Formulation of business plans and project appraisal. Contents of business plans, significance and formulation. Guide lines for formulating project reports: Methods of project appraisal –economic, financial, market analysis, technical feasibility and managerial competency environmental clearance. Forms of business ownership, sole proprietor ship, partnership, company, co-operative. Selection of appropriate forms of ownership structure.	**06**

04	**Financing of Enterprise** 4.1 Source of finance: internal and external sources, capitalization, term loans- short term finance, venture capital, export finance. Institutional finance- commercial banks, other financial institution, institutional support. 4.2 Support Institutions: National small industries, corporation ltd, small industries development organization, small scale industry board, state small industry development organization, small industries service institutes, direct industry centre, technical consultancy organizations 4.3 Government policy and taxation: Benefits to small scale industry, tax benefits, incentives and concession for small scale industries. Government policies for small scale enterprises and industrial policy resolutions. 4.4 Accounting for small enterprises: Objectives of accounting, accounting process, journal ledger, trial balance, final accounts, balance sheet preparation.	**06**
05	**Government strategies:** 5.1 Growth of enterprises: Objectives of growth, stages and types of growth- Expansion diversification, joint venture, mergers and acquisitions, sub contracting and financing. 5.2 Sickness in small industries: Meaning of industrial sickness, signals and symptoms of industrial sickness, causes and consequences, corrective measures to curb sickness, government policies on revival of sick units. 5.3 E-commerce: Basic concepts, advantages and disadvantages.	**06**
06	**Management** Importance and scope of management , elements of working capital management, Inventory management, production management, marketing management, TQM, Human resource management, Regulatory acts, Fundamentals of housekeeping and safety. Social responsibility of business.	**10**

Term Work

Term work shall consist of;

1. Preparation of feasibility report / project report pertaining to selected business opportunity.
2. One presentation based on one of the topics selected from the syllabus.
3. Exercise in accounting and preparation of balance sheet.
4. At least one assignment selected from each modules.

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

Project report	**10** marks
Presentation and 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. *Entrepreneurship*, Roy, Rajiv, Univ. Press.
2. *Entrepreneurship*,/ Hisrich, McGraw Hill
3. *Entrepreneurship Development*, Kumar, New- Age.
4. *Entrepreneurship Development*, Kaulgud, Thomson Learning.
5. *Entrepreneurship: Theory & Practices*, Saini, Wheeler.
6. *Entrepreneurship Development*, Dr. S.S. Khanka S. Chand.

Course Code	Course/Subject Name	Credits
PEE8015	**World Class Manufacturing**	**3+1**

Objectives

1. To familiarize with the concepts of Business excellence and competitiveness.
2. To apprise with the need to meet the business challenges and for being ready to meet the future manufacturing competition.
3. To acquaint with the current manufacturing scenario and the need to move from a domestic to a world class global manufacturer status.

Outcomes: Learner will be able to …

1. Illustrate relevance and basics of World Class Manufacturing.
2. Relate factors of competitiveness and performance measures based on which, global manufacturing success is bench marked.
3. Illustrate current Status of Indian Manufacturing scenario
4. Design and develop a roadmap to achieve world class manufacturing status.

Module	Details	Hrs.
01	**Historical Perspective** World class organizations: Meaning of world class. Competitiveness and Performance measures. Criteria for world class organizations in Manufacturing. Competing in World markets. Review of frameworks in World Class Manufacturing (WCM). Models for manufacturing excellence: Schonberger, Halls, Gunn & Maskell models and Business Excellence.	**06**
02	**Benchmark, Bottlenecks and Best Practices** Concepts of benchmarking, Bottleneck & best practices. Best performers, Gaining competitive edge through world class manufacturing, Value added manufacturing, Value Stream mapping, Eliminating different types of waste. Lean Thinking (Toyota Production System), Six Sigma, Theory of Constraints.	**08**
03	**System and Tools for World Class Manufacturing** Improving Product & Process Design: SQC, Statistical Process Control, Quality Function Deployment (QFD), Seven Basic Quality Tools, FMS, Poka Yoke, 5-S, Optimizing Procurement & stores practices, Total Productive maintenance and Visual Control.	**08**
04	**HR Dimensions in WCM – WCM Strategy Formulation** 4.1 Adding value to the organization: Organizational learning, techniques of removing Root cause of problems, People as problem solvers, New organizational structures. 4.2 Associates: Facilitators, Teams man ship, Motivation and reward in the age of continuous improvement.	**06**

05	**Characteristics of WCM Companies:** Performance indicators like POP, TOPP and AMBITE systems. Other features of WCM: Supply Chain Management & key issues in SCM, Agile Manufacturing, Green Manufacturing, Role of Information system in WCM, Introduction to Knowledge management, Study of various performance measures in world class organization.	**06**
06	Evolution of TQM concepts and framework for TQM, Customer satisfaction, Employee involvement, Continuous process improvement, Supplier partnership, Performance measures. **WCM - the Indian Scenario** Case discussions on leading Indian companies' efforts towards world class manufacturing and the task ahead.	**06**

Term Work

Term work shall consist of at least one assignment from each module from syllabus and at least three (3) case studies and analysis based on the syllabus.

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

- Case studies with inferences: **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. *World Class Manufacturing – Strategic Perspective*, Sahay B.S., Saxena K B C and Ashish Kumar, Mac Milan Publications, New Delhi.
2. *World Class Manufacturing - The Lesson of Simplicity,* Schonberger R. J, Free Press, 1986
3. *Management strategy: achieving sustained competitive advantage*, Marcus, A. A., New York: McGraw-Hill/Irwin, 2011.
4. *Manufacturing Strategy: Process and Content*, Voss C. A., Chapman & Hall, London, 1992.
5. *Lean production simplified*, Pascal. D., 2nd Edition, Productivity Press, 2007
6. *Total Quality Management*, Besterfield, D. H., Pearson Education, 1999.
7. *Advanced Operations Management,* Mohanty R. P., Deshmukh S. G., Pearson Education,2003.
8. "*Managing Technology and Innovation for Competitive Advantage*", Narayanan V.K, Prentice Hall, 2000.
9. "*Making Common Sense Common Practice – Models for manufacturing Excellence*", Ron Moore, Butter worth Heinmann.
10. *The Toyota Way – 14 Management Principles*", Jeffrey K.Liker, Mc-Graw Hill, 2003.
11. "*Operations Management for Competitive Advantage*", Chase Richard B., Jacob Robert., 11th Edition , McGraw Hill Publications, 2005.

Course Code	Course/Subject Name	Credits
PEE8016	**Mechatronics**	**3+1**

Objectives

1. To familiarise the students with the architecture of the mechatronics system.
2. To study various actuators applicable to a Mechatronics system.
3. To understand the interfacing of the electromechanical devices.

Outcomes: Learner should be able to…

1. Identify the suitable sensor and actuator for a mechatronics system
2. Develop the skill required for interfacing the electromechanical system.
3. Illustrate basic aspects of design and development of a mechatronic system

Modules	Details	Hrs.
01	**1.1 Introduction to Mechatronics**. Key element of mechatronics. mechatronics systems in a factory, home and business applications. Basic Components of mechatronics systems. Advantages of mechatronics.	04
02	**Electrical Actuating systems** DC motors : Principles of operation of DC motor, Modelling of DC motor behaviour, Heat dissipation in DC motor, Servo Amplifier, DC motor service drive. Stepper Motors: Characteristics of a Stepper motor, Classification of a Stepper motor, Principle of Operation, Stepper motor performance, AC Induction motors: Three phase motor.	06
03	**Pneumatic and Hydraulic actuating systems** Components of pneumatic and hydraulic systems, pumps, compressor, filter, control valves, pressure regulation, relief valves, accumulator. **Piezoelectric drives.** **Selection of actuator**	06
04	**Development of circuits for industrial automation.** Electro-pneumatic systems, Electro-hydraulic system, hydro-pneumatic system, Development of circuits for Industrial automation. **Programmable Logic Controller (PLC) in automation**: Basic structure, I/O processing. Ladder logic diagram, PLC for industrial process control, Selection of PLC.	08
05	**System Interfacing and Data Acquisition** Data Acquisition systems (DAQs), data loggers, supervisory control and data acquisition, interfacing requirements, buffers, handshaking, polling and interrupt, digital communication, parallel communication, serial communication interface, universal asynchronous receiver and transmitter (UART)	08
06	**Mechatronics case studies:** Autonomous Mobile Root, Wireless Surveillance Balloon, Fire Fighting robots, Cantilever beam vibration control using piezo sensors and actuators, Car engine management.	07

Course Project

There will be a course project, which students shall integrate based on the knowledge gained during the course. The projects shall be developed by team of maximum four students. Further, course project shall demonstrate design, setup, and implementation of a simple mechatronics system.

Term Work

Term work shall consist of minimum 6 experiments, one assignment on first three modules, one each on module 4 and module 5 respectively and a report on course project

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

- Laboratory work (Experiments) **:** **10 marks**
- Assignments : **05 marks**
- Course project: **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.

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. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc.
2. Applied Mechatronics- A. Smaili and F. Mrad, *OXFORD university press.*
3. Mechatronics System Design , Shetty and Kolk *CENGAGE Learning, India Edition*
4. Introduction to Mechatronics and Measurement Systems , Alciatore and Histand *Tata McGraw-Hill*
5. Mechatronics, Necsulescu, *Pearson education.*
6. Mechatronics - Electromechanics and Control Mechanics , Mill *Springer-Verlag*
7. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton *Pearson eduaction*
8. Mechatronics - Electronics in products and processes , Bradley, et al. *Chapman and Hall*
9. Mechatronics - Mechanical System Interfacing , Auslander and Kempf, *Prentice Hall*
10. Introduction to Mechatronics, Appu Kuttan K.K., *OXFORD Higher Education*
11. The Art of Electronics, Horowitz and Hill Cambridge, *University Press*
12. Electromechanical Design Handbook , Walsh, *McGraw-Hill*
13. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
14. Handbook of Electromechanical Product Design , Hurricks Longman, John Wiley, *Addison Wesley*
15. Principles and Applications of Electrical Engineering , Rizzoni *Irwin Publishing*

16. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics , Kamm *IEEE*
17. Modeling and control of Dynamic Systems, Macia and Thaler, *CENGAGE Learning, India Edition*
18. Mechatronics, A. Smaili, F. Mrad, *OXFORD Higher Education.*
19. Pneumatic and Hydraulic Control Systems: Aizerman. M.A.
20. Industrial Hydraulics: Pippenger
21. Vickers Manual on Hydraulics
22. Computer Numerical Control of Machine Tools: Thyer. G.R.
23. Pneumatic Applications: Deppert Warner & Stoll Kurt
24. Mechanization by Pneumatic Control: Vol. 1 & 2 Deppert Warner & Stoll kurt
25. Hydraulics and Pneumatics for Production: Stewart
26. Hydraulic Valves and Controls: Pippenger
27. Fundamentals of pneumatics: Festo series
28. Automatic Control Engineering: Francis. H. Raven.
29. Mechatronics, Nitaigour Mahalik, *Tata McGraw-Hill*
30. Mechatronics, *HMT*
31. *System Identification*: Theory for the User (2nd Edition) , Lennart Ljung
32. Design with Microprocessors for Mechanical Engineers, Stiffler *McGraw-Hill*

Course Code	Course/Subject Name	Credits
PEE8017	**Industrial Robotics**	**3+1**

Objectives

1. To acquaint with significance of robotic system in agile and automated manufacturing processes.
2. To make conversant with robotic elements/ peripherals, their selection and interface with manufacturing equipments.
3. To study the basics of robot kinematics.

Outcomes: Learner will be able to..

1. Acquire skills in understanding robot language and programming.
2. Acquire skill in robot task planning for problem solving.
3. Develop skills in understanding various sensors, robot peripherals and their use & deployment in manufacturing system.
4. Develop skills in identifying areas in manufacturing where robotics can be deployed for enhancing productivity.

Module	Details	Hrs.
01	**Introduction** Automation, robotics, Robotic system & Anatomy, Classification and Future Prospects.	**02**
02	**Drives** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system. **Robot & its Peripherals** **End Effecters:** Type mechanical and other grippers, Tool as end effecter. **Sensors:** Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment.	**12**
03	**Machine vision** Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications. **Programming for Robots** Method, Robot Programme as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	**12**
04	**Robot Kinematics** Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics.	**08**
05	**Root Intelligence & Task Planning** Introduction, State space search, Problem reduction, use of predictive logic, Means. Ends Analysis, Problem solving, Robot learning and Robot task planning.	**08**
06	**Robot application in manufacturing** Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, Social issues & Economics of Robotics.	**08**

Term Work

Term work shall consist of at least one assignment from each module from syllabus, minimum six (6) practical's/exercises including programming of robots based on syllabus.

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

- Practicals/exercises: **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. *Industrial Robotics, Technology, Programming & Applications*, Grover, Weiss, Nagel, Ordey, Mc Graw Hill.
2. *Robotics: Control, Sensing, Vision & Intelligence*, Fu, Gonzalex, Lee, Mc Graw Hill.
3. *Robotic technology & Flexible Automation*, S R Deb. TMH.
4. *Robotics for Engineers*, Yoram Koren , Mc Graw hill.
5. *Fundamentals of Robotics*, Larry Health.
6. *Robot Analysis & Control*, H Asada, JJE Slotine.
7. *Robot Technology*, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.
8. *Handbook of Industrial Robotics*, Ed. Shimon.John Wiley.

Course Code	Course/Subject Name	Credits
PEE8018	**Product Design and Development**	**3+1**

Objectives

1. To acquaint with various approaches in designing and developing new products.
2. To familiarize with various software solutions for designing and developing products.
3. To familiarize with modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling, etc.

Outcomes: Learner will be able to…

1. Develop competency in designing and developing products right from the conceptual level incorporating cost effective solutions.
2. Get familiarized with computer aided product design approach.

Module	Details	Hrs.
01	1.1 Introduction: Definition of product design, Classification of products, Design by evolution, Design by innovation, Various phases in product development and Design, Morphology of Design, Considerations in product design, Product specifications. 1.2 Conceptual Design: Market research, Need based origin of product, Technology driven products, Analysis of ideas from various angles of design methodology and user needs, Function analysis and component process study, 2-D and 3-D representations in the form of concept drawing, Computer generated images, dummy and prototypes. 1.3 Materials: Overview of materials including new generation materials, Tailor made material concepts, Material selection process.	**05**
02	2.1 Design for manufacturing (DFM): Producibility requirements, Accuracy and Precision requirements, Forging and casting design, Design for pressed, mechanical components, powder metallurgical components, Die cast and special cast components, expanded metals and wire forms. 2.2 Design for Assembly (DFA): Analysis of assembly requirements, Standardization, Ease of Assembly and disassembly, Design for bolted, welded and riveted components, Design for hinge and snap fit assemblies, maintenance, consideration of handling and safety, Modular concepts.	**05**
03	3.1 Strength considerations in Design: Criteria and objectives, Designing for uniform strength, Designing for stiffness and rigidity, Practical ideas for material saving in design of ribs, corrugations, rim shapes, bosses, laminates, etc. 3.2 Designing with plastics: Mechanical behavior, special characteristics and considerations, Design concepts for product features to be manufactured by various production process technologies, Special considerations for designing of components for load bearing applications, Designing for safety, Reliability and environmental considerations.	**06**

04	Value Engineering: Product value and its importance, Value analysis job plan, Steps to problem solving and value analysis, Value analysis tests, Value Engineering idea generation check list, Material and process selection in value engineering, Cost reduction, case studies and exercises.	**04**
05	5.1 Product Ergonomics: Anthropometry, Environmental conditions, thermal, noise, vibration, displays, illusions, Psycho and psychological aspects in design, Man-machine information exchange. 5.2 Product Aesthetics: Visual awareness, Form elements in context of product design, Concepts of size, shape and texture, Introduction to colour and colour as an element in design, Colour classifications and dimensions of colour, Colour combinations and colour dynamics, Interaction / communication of colours, Psychological aspects of colours, generation of products forms with analogies from nature. 5.3 Product Graphics: Graphics composition and layout, Use of grids in graphics composition, Study of product graphics and textures. 5.4 Creativity: Role of creativity in problem solving, Vertical and lateral thinking, Brain storming, Synectics, Group working dynamics, Adaptation to changing scenarios in economics, social, cultural and technological fronts, Anticipation of new needs and aspirations.	**10**
06.	6.1 Software solutions: Software for drafting, modeling, assembly, detailing, CAM interfacing, Rapid tooling/rapid prototyping, etc. 6.2 Modern Applications: Concurrent Engineering, QFD, Robust Design, Sustainable Design, Rapid Prototyping, Rapid Tooling, Product Life Cycle Management techniques and application areas.	**06**

List of Exercises

1. At least two presentations pertaining to topics selected from syllabus contains.
2. Redesign of an existing product with 3D modeling to solve indentified lacuna present in the product.
3. One assignment on understating design procedure and documenting and interpreting data.
4. One 3-D modeling on colour balance and radii manipulation.
5. One assignment on product detailing of moulded component.

Term Work

Term work shall consist of exercises listed in the above list

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. *Design Fundamentals*, R. G. Scott.
2. *Design methods inter science*, Jomes.
3. *Creative Engineering Design*, Buhl H. R.
4. *The Science of Engineering Design*, Holt, Hill Percy H.
5. *Ergonomics*, Merilyn Joyce, Ulrika Waller Steiner.
6. *Human Factors in Engineering & Design*, 4th edition
7. *Human Engineering Guide & Equipment Design*, Morgon C. T. & Others
8. *Barron D.ed, Creativity*, New York, Art Directors
9. *Design for Production*, Baldwin E. W. & Niebel B. W. Edwin, Homewood Illinois.

Course Code	Course/Subject Name	Credits
PEE8019	**Sustainable Engineering**	**3+1**

Objectives

1. To provide depth of knowledge and exposure to environmental related issues.
2. To appraise the significance of sustainable development for future survival.
3. To appraise about the ongoing global issues in sustainable engineering front.

Outcomes: Learner will be able to..

1. Illustrate appropriate business responses to environmental problems.
2. Provide technical inputs for energy saves and energy recycling measures.
3. Develop a knowledge base in selecting and incorporating appropriate conversion technology in management of waste and pollutants.
4. Acquire skills to work as responsible partners in the ongoing efforts for sustainable development.

Module	Details	Hrs.
01	**Sustainability Concepts** Concepts related to Sustainability and sustainable development, Environmental problems,- pollution, land degradation, Ecosystem, biodiversity, energy availability, global warming and other natural disasters.	**04**
02	**Management of waste and pollutants** Nature and hazards of pollutants, types and sources of solid and hazardous wastes, Need for solid and hazardous waste management, waste segregation and processing, processing technologies, biological and chemical conversion technologies, energy recovery. Management of effluents.	**07**
03	**Implications of conversion technology** Innovations for reuse and recycling, concept of ecoefficiency, sustainable loading on ecosystem, energy audits, product life cycle assessment, environmental analysis, materials for sustainable design, Industrial case studies and discussion.	**07**
04	**Sustainability Integration** Materials for sustainability, Materials for future, selection of energy saving and effective materials, Recycling of materials, Toxicity and related health hazards, control on non –renewable material use.	**07**
05	**Measures for environmental preservation** Impact of culture, political and economical changes in environment and environmental management. Alternative product and process change, Environmental standards like ISO-14000. Environmental legislations- carbon footprint, anti-pollution boards, global warming, Kyoto protocol. Global sustainability agenda and green manufacturing.	**06**
06	**Strategies and decision making** Marketing and operating strategies based on environmental issues. Sustainability awareness, Role of I.T, sustainable innovations and promotions, sustainable rating schemes, Eco-labeling programmers, disaster management, Human values and professional ethics, case studies.	**05**

Term Work

Term work shall consist of;

1. One report pertaining to any one of the environmental related issues.
2. At least one presentation from the topics selected from the syllabus.
3. Preparation of an exhaustive write up on creating sustainable manufacturing units.
4. At least four assignments selected from the topics of the syllabus.

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

- Laboratory work (report/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. *Sustainable development*, N.k.Ghosh Roy, Ane Books PVT LTD.
2. *Design for Environment: A Guide to sustainable product development*, Joseph Fiksel Tata McGraw Hill.
3. *Green Management*, M. Karpagam, Geetha Jaikumar, Ane Books PVT LTD.
4. *Essential Environment Studies*, S.P.Mishra , S.N. Pandey, Sheth Publishers.
5. *Environmental Studies*, E Bharucha.
6. *Plastics and sustainability: Towards a peaceful Co-existence between Bio-based and fossil fuel based plastics*, Tolinski.

Course Code	Course/Subject Name	Credits
PEE8010	**Maintenance Engineering**	**3+1**

Objectives

1. To acquaint with principles, functions and practices adopted in industry for the successful management of maintenance activities.
2. To appraise the importance of maintenance in the cost reduction.
3. To make conversant with preventive maintenance and breakdown maintenance functions.
4. To appraise with modern approaches in the field of maintenance.

Outcomes: Learner will be able to…

1. Acquire awareness and interest about the significance of maintenance function.
2. Develop skills to diagnose and trace the faults.
3. Get an exposure to the ongoing trends in the field of science.

Module	Details	Hrs.
01	**Principles of Maintenance Planning :** Introduction to maintenance, Types of maintenance, Basic Principles of maintenance planning, Objectives of planned maintenance activity, Importance and benefits of sound Maintenance systems, Reliability and machine availability trade off, concepts of MTBF, MTTR and MWT and factors of availability.	**06**
02	**Preventive Maintenance** Significance of Preventive maintenance, maintenance schedules, repair cycle, Principles and methods of lubrication.	**06**
03	**Breakdown Maintenance** Logical fault location methods, Sequential fault location, repair methods for beds, sideways, shafts, spindles, gears, keys, lead screws, bearings and similar drive elements.	**06**
04	**Condition Monitoring** Condition Monitoring, Cost comparison with and without CM, On-load testing and offload testing, Methods and instruments for CM, Temperature sensitive tapes, Pistol thermometers and wear-debris analysis	**08**
05	**Maintenance of Material Handling Equipment** Maintenance of Material handling equipment like crane, fork lift and conveyors.	**04**
06	**Maintenance Management** Maintenance strategies, Types and techniques, planned and unplanned maintenance, Computer aided maintenance, maintenance scheduling, spare part management, inventory control, maintenance records and documentation. Concepts of Total Productive Maintenance (TPM). Predictive maintenance techniques.	**08**

Term Work

Term work shall consist of at least two assignments from each module from syllabus and minimum two presentations on case study/various aspects related to maintenance.

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

- Assignments: **10** marks
- Presentation: **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. *Industrial Maintenance Management*, Srivastava S.K., S. Chand and Co.
2. *Installation, Servicing and Maintenance*, Bhattacharya S.N., S. Chand and Co.
3. *Maintenance Planning*, White E.N., I Documentation, Gower Press.
4. *Industrial Maintenance*, Garg M.R., S. Chand & Co.
5. *Maintenance Engineering Hand book*, Higgins L.R., McGraw Hill.
6. *Condition Monitoring*, Armstrong, BSIRSA.
7. *Handbook of Condition Monitoring*, Davies, Chapman &Hall.
8. *Advances in Plant Engineering and Management*, Seminar Proceedings – IIPE.