Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under
FACULTY OF TECHNOLOGY

Production Engineering
Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per Choice Based Credit and Grading System
with effect from the AY 2016-17
Co-ordinator, Faculty of Technology’s 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 (PEOs) and give freedom to affiliated Institutes to add few (PEOs). It is also resolved that course objectives and course outcomes are 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.

Choice 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 assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai
Chairman’s 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 the University of Mumbai, I am happy to state here that, the Program Educational Objectives of the Undergraduate Program in Production Engineering, which comes under the same board, were finalized during the multiple brain storming sessions, which was attended by more than 25 members from different affiliated Institutes of the University. They are either Heads of Departments or their senior representatives from the Department of Production Engineering. The Program Educational Objectives finalized for the undergraduate program in Production Engineering are listed below;

1. To prepare the Learner with a sound foundation in the mathematical, scientific and engineering fundamentals related to Manufacturing and its strategies.
2. To motivate the Learner in the art of self-learning and to use modern tools for solving real life problems.
3. To inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in the Learner’s thought process.
4. To prepare the learner to face industrial challenges through practical exposure in an industrial environment.
5. To prepare the Learner for a successful career in Indian and Multinational Organizations.

In addition to Program Educational Objectives, for each course of the program, objectives and expected outcomes from a learner’s point of view 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 stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai
Program Structure for  
B.E. in Production Engineering  
University of Mumbai  
(With Effect from 2017-2018)  
S.E. (Production) Sem.-III

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** Common with Automobile Engineering, Mechanical Engineering and Civil Engineering
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** Common with Automobile Engineering, Mechanical Engineering and Civil Engineering
### Course Details

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* Theory for entire class to be conducted.
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## Examination Scheme

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## Department Level Optional Course II

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>PEDLO6011</td>
<td>Manufacturing Planning and Control</td>
</tr>
<tr>
<td>PEDLO6012</td>
<td>Refrigeration and Air Conditioning</td>
</tr>
<tr>
<td>PEDLO6013</td>
<td>Reliability Engineering</td>
</tr>
<tr>
<td>PEDLO6014</td>
<td>Industrial Robotics</td>
</tr>
<tr>
<td>PEDLO6015</td>
<td>Rapid Prototyping and Manufacturing</td>
</tr>
</tbody>
</table>
### Course Code

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
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<tr>
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#### Examination Scheme

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Theory</th>
<th>Internal Assessment</th>
<th>End Sem. Exam. Avg.</th>
<th>Exam. Duration (in Hrs)</th>
<th>Term Work</th>
<th>Pract. /Oral</th>
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**Total**

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* Industrial Training and Project work should be of 24 weeks. (Learners load – 8 hours a day and 5 days a week translates into 40 contact hours per week)

**Workload of Teacher: Contact hours for project guidance – One hour per student per week**
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
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<tbody>
<tr>
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<tr>
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<td>04</td>
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### Examimation Scheme

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<td>Exam. Duration (in Hrs)</td>
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</table>
Objectives
1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex variables.

Outcomes: Learner will be able to…
1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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<tbody>
<tr>
<td>1</td>
<td>Laplace Transform</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>1. Function of bounded variation, Laplace Transform of standard functions such as $1, t^n, e^{at}, \sin at, \cos at, \sinh at, \cosh at$</td>
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<tr>
<td></td>
<td>1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof)</td>
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<tr>
<td></td>
<td>$L{e^{at} f(t)}, L{-\frac{f(t)}{t}}, L{\int_0^t f(u)du}, L{\int_0^t f(t)du}$ Laplace Transform of periodic functions</td>
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<tr>
<td></td>
<td>1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof).</td>
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<tr>
<td></td>
<td>1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable</td>
<td></td>
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<tr>
<td>2</td>
<td>Complex variables:</td>
<td>08</td>
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<tr>
<td></td>
<td>2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates.</td>
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<tr>
<td></td>
<td>2.2 Milne-Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation</td>
<td></td>
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<tr>
<td>3</td>
<td>Complex Integration:</td>
<td>08</td>
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<tr>
<td></td>
<td>3.1 Line integral of a function of a complex variable, Cauchy’s theorem for analytic functions(without proof)Cauchy’s integral formula (without proof)Singularities and poles:</td>
<td></td>
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<tr>
<td></td>
<td>3.2 Taylor’s and Laurent’s series development (without proof)</td>
<td></td>
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<tr>
<td></td>
<td>3.3 Residue at isolated singularity and its evaluation</td>
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</tr>
<tr>
<td></td>
<td>3.4 Residue theorem, application to evaluate real integral of type</td>
<td></td>
</tr>
</tbody>
</table>
\[ \int_{0}^{2\pi} f(\cos \theta, \sin \theta) d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x) dx \]

Fourier Series:

5.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet’s conditions. Fourier series of periodic function with period \( 2\pi \) and \( 2l \)

5.2 Dirichlet’s theorem (only statement), even and odd functions, Half range sine and cosine series, Parseval’s identities (without proof)

5.3 Complex form of Fourier series

Partial Differential Equations:


5.3. Heat equation, steady-state configuration for heat flow

5.4. Two and Three dimensional Laplace equations

Correlation and curve fitting

6.1. Correlation-Karl Pearson’s coefficient of correlation – problems, Spearman’s Rank correlation problems, Regression analysis- lines of regression (without proof) – problems

6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, \( y = ax + b \), \( y = ax^2 + bx + c \) and \( y = ae^{bx} \)

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks

2. Question 1 will be compulsory and should cover maximum contents of the curriculum

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 any module other than module 3)

4. Only Four questions need to be solved.

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
Course Code | Course Name | Credits
--- | --- | ---
PEC302 | Applied Thermodynamics | 04

**Objectives:**
1. To acquaint with basic concepts of Thermodynamics and its applications
2. To familiarize with the use of thermodynamic tables and charts to obtain appropriate property data to solve relevant problems.
3. To familiarize with the application of ideal cycle analysis to simple heat engine cycles.

**Outcomes:** Learner will be able to ….
1. Illustrate the basic concepts related to a thermodynamic system, surrounding, thermodynamic properties and processes.
2. Apply first law of thermodynamics to solve different types of problems on open and closed systems.
4. Demonstrate the importance of entropy and clausius inequality with its application to solve problems.
5. Apply properties of steam to solve problems using steam table and Mollier chart.
6. Analyze various thermodynamic cycles generating powers to solve problems.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Thermodynamic concepts:</strong> Microscopic and Macroscopic viewpoints in thermodynamics, thermodynamic system, thermodynamic properties of system state, path, processes and cycles, point function and path function internal energy and enthalpy, reversible and irreversible process, asistatic process, thermodynamic work, heat, temperature, thermodynamic equilibrium and Zeroth law of thermodynamics. <strong>First law of Thermodynamics:</strong> Statement, First law applied to cyclic and non-cyclic process, Application to non-flow processes viz. Constant volume, constant pressure, constant temperature, adiabatic and polytrophic processes. Heat and work calculations.</td>
<td>12</td>
</tr>
<tr>
<td>02</td>
<td><strong>First law applied to open systems:</strong> Flow work, Steady flow energy equation (SFEE), SFEE applied to nozzle, turbine, compressor, boiler, condenser etc.</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td><strong>Second law of Thermodynamics:</strong> Limitations of first law of thermodynamics, thermal reservoir, heat engine, thermal efficiency, reversed heat engine, coefficient of performance, Kelvin-Planck and Clausius statements and their equivalence. PMM I and PMM II, Carnot cycle, Carnot’s theorem, its Corollaries.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Entropy:</strong> Definition of entropy, a property, change of entropy, temperature-entropy plot, Clausius inequality theorem, principle of increase of entropy, entropy changes of an ideal gas during reversible processes. <strong>Introduction to Availability and irreversibility:</strong> Available and Unavailable energy, Dead state, Useful work and Maximum work.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Properties of steam:</strong> Dryness fraction, enthalpy, internal energy and entropy. Critical point and Triple point, Use of steam tables and h-s diagram for calculating steam properties.</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td><strong>Vapour power cycle:</strong> Rankine cycle, Modified Rankine cycle, variables affecting the efficiency of Rankine cycle, Reheat cycle and Regenerative cycle.</td>
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</tbody>
</table>

**Theory Examination:**
1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from the module 3 then part (b) will be from any module other than module 3)

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

**Internal Assessment:**
Assessment consists of two tests out of which; one should be a 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 a course project.

**Reference Books:**

5. *Thermal Engineering* by P. L Ballany, Khanna Publishers
Table:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PEC303</td>
<td>Manufacturing Engineering - I</td>
<td>04</td>
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</table>

Objectives:
1. To impart the knowledge of machine tools and basic machining processes like turning, drilling, milling, broaching etc.
2. To impart the fundamentals of various metal cutting practices, fundamentals of machine tools and processes.

Outcomes: Learner will be able to…
1. Describe types of machine tools, their classification, specifications and constructional features.
2. Illustrate machine tools capabilities, limitations of machining operations to generate cylindrical, circular and planar components.
3. Demonstrate different kinds of cutting tools with their significance of work-piece interface.
4. Describe features and applications of screw thread processes.
5. Describe features and applications of gear manufacturing processes.
6. Demonstrate finishing processes like grinding, reaming, honing, lapping and burnishing.

Module | Contents                                                                 | Hrs. |
-------|--------------------------------------------------------------------------|------|
01     | Introduction to Manufacturing Processes: Definition, need and classification of manufacturing process based on chip-less and chip-removal processes. Various generating & forming processes. Classification of machine tools based on form of the work piece and on field of application. Cutting off Machines: Power hacksaws, band saw and circular saw, friction saw and abrasive cutting off machines, field of applications and limitations. | 06   |
02     | Lathe Machine: Lathe operations, Turning parameters (speed, feed, depth of cut, MMR), Lathe Components, Lathe specifications, work and tool holding devices & accessories, single point cutting tool nomenclature, Taper turning types, lathe machines types and their difference. Machining time (Numerical). | 08   |
03     | 3.1 Drilling machine: Drilling operations, work and tool holding devices, Drill nomenclature, Drilling machine types, Deep hole drilling (fundamentals only), Introduction to Boring & Boring machine. Machining time (Numerical). 3.2 Broaching Machine: Broaching process, circular broach nomenclature and types of broaches, broaching machine types, Advantages and Limitations. | 06   |
04     | 4.1 Milling Machine: Milling operations and their difference, Milling Parameters, special attachments (Dividing head) and accessories, milling machines types, Types of Milling cutters and Machining time (Numerical). 4.2 Reciprocating Machine: Shaping machines: types of shapers, working of shaping machine, quick return mechanisms, shaper operations, Machining time. Planning machines: types of planning machines, shaper vs. planer. Slotting machines types of slotting machines. | 10   |
**Screw Threads:** Thread production process – Machining (thread chasing, thread milling, thread whirling, and die threading & tapping), Thread rolling, Thread grinding. (Tool geometry omitted).

**Gear Teeth:** Gear hobbing, principles of hobbing (kinematics omitted). Hobbing techniques, hob material (tool geometry omitted). Gear finishing processes-gear shaving, gear lapping, gear grinding and gear burnishing.

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**Grinding Machine:** Grinding principle, Grinding machines types and operations, grinding wheels specification, balancing of grinding wheels, truing, dressing and shaping of grinding wheels.


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**Theory Examination:**
1. Question paper will comprise of total 6 questions, each of 20 Marks.
2. Only 4 questions need to be solved.
3. Question 1 will be compulsory and based on maximum part of the syllabus.
4. Remaining questions will be mixed in nature (for example suppose Q.2 has part (a) from the module 3 then part (b) will be from any module other than module 3).

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

**Internal Assessment:**
Assessment consists of two tests out of which; one will be a 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 a course project.

**Reference Books:**
Course Code | Course Name | Credits
------------|-------------|--------
PEC304      | Materials Science and Engineering | 03

**Objectives:**
1. To familiarize with basic engineering materials, their structure-properties-performance relationship and applications.
2. To acquaint with different types and causes of failure of components in various Engineering applications.
3. To familiarize with properties, manufacturing processes and applications of polymer matrix composites.

**Outcomes:** Learner will be able to…
1. Demonstrate the process of solidification of metals along with various types of crystal imperfections.
2. Distinguish between various modes of material failure.
3. Analyze various alloy phase diagrams including iron – iron carbide diagram.
4. Select proper heat treatment process for steel in order to attain desirable properties.
5. Describe the properties with applications of alloy steels/ non - ferrous metals.
6. Describe the properties with applications of composites/ nano structured materials.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>3.1 <em>Solidification of metals:</em> Formation of solids from liquids of pure metals and alloys. Ingot defects and their remedies. Single crystal and polycrystalline materials. Anisotropy. Noncrystalline solids. 3.2 <em>Theory of Alloying:</em> Significance of alloying: definition, classification and properties of different types of alloys.</td>
<td>08</td>
</tr>
</tbody>
</table>
### 3.3 Alloy Phase Diagrams:

### 3.4 The Iron-Iron Carbide Phase Diagram:

#### 4.1 Principles of Heat treatment:

#### 4.2 Heat treatment Process:
- **Annealing**: Principle, process, and properties developed on Full Annealing; Spheroid zing; Process annealing, Stress relieve annealing.
- **Normalizing**: The process and its applications
- **Hardening**: Hardening media, Salt baths, Hardenability. Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process.
- **Surface hardening**: Surface Hardening methods. Their significance and applications. Carburizing, Nitriding, Cyaniding, Carbon-nitriding, Induction hardening and Flame hardening processes.

#### 4.3 Heat treatment defects:

#### 5.1 Effect of Alloying Elements in Steels:
- **Tool steels**: Important compositions and applications.
- **Stainless steels**: Important compositions and applications.

#### 5.2 Non Ferrous Metals and their Alloys:
Basic Treatment Only. Important non-ferrous materials like Aluminum, Copper, Nickel, Tin, and Zinc – Their alloys, properties and applications.

#### 6.1 Composites:

#### 6.2 Nano-structured materials:
Introduction, Concepts, synthesis of nano materials, examples, applications and nano composites.

#### 6.3 Biomaterials:
Introduction, examples and applications.

#### 6.4 Smart materials:
Introduction, examples and applications.

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**Assessment:**

**Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

Course Code: PEC305
Course Name: Mechanics of Solids
Credits: 04

**Objectives:**
1. To impart the concept of various types of forces, their modes of action and resulting stresses and strains on various materials under various operating conditions.
2. To impart the knowledge of Bending Moment, Shear force and Moment of Inertia as applied on various structures.

**Outcomes:** Learner will be able to...
1. Illustrate stress-strain behavior of various materials under load.
2. Demonstrate the basic concepts related to material properties and stress strain behavior of material.
3. Illustrate the basic concept of Bending moment and Shear force.
4. Develop skills to analyze the stresses and deformation due to axial loading.
5. Illustrate basic concepts of bending, torsion, buckling, deflection and strain energy.
6. Develop skills to visualize with analysis of stresses under various loading conditions.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Direct stress and direct strain:</strong> Concept of different types of stresses; Stress–strain curves for ductile and brittle material; factor of safety; deformation of uniform/tapering rectangular and circular and circular cross–section bars; deformation of members made of composite materials; shear stress and shear strain; Poisson's ratio; volumetric strain; bulk modulus; relationship between Young's modulus, bulk modulus and modulus of elasticity; temperature stresses in simple and compound bars. <strong>Introduction to Moment of Inertia:</strong> Theorem of parallel and perpendicular Axis, Polar Moment of Inertia.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Shear Force and Bending Moment:</strong> Axial force, shear force and bending moment diagrams for statically determinate beams excluding beams with internal hinges for different types of loading.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>3.1 Theory of Bending:</strong> Flexure formula for straight beams; principal axes of inertia; moments of inertia about principal axes; transfer theorem. Simple problems involving application of flexure formula, section modulus and moment of resistance of a section. <strong>3.2 Shear Stress in Beams:</strong> Distribution of shear stress across plane sections used commonly for structural purposes; shear connectors.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>4.1 Bending Moment Combined with Axial Loads:</strong> Application to members subjected to eccentrics loads, core of section. <strong>4.2 Deflection of Beams:</strong> Deflection of cantilevers sample supported and overhanging beams using double integration and Macaulay’s method for different types of loadings</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>5.1 Theory of Torsion:</strong> Torsion of circular shafts—solid and hollow, stresses in shafts transmitting power, shafts in series and parallel. <strong>5.2 Principal Stresses:</strong> General equations for transformation of stress; principal planes and principal stresses, determination using Mohr’s circle maximum shear stress, principal stresses in beams principal stresses in shafts subjected to torsion, bending and axial thrust; concept of equivalent torsion and bending moments.</td>
<td>08</td>
</tr>
</tbody>
</table>
6.1 **Struts:** Struts subjected to axial loads, concept of buckling. Euler's formula for struts with different support conditions. Euler's and Rankin's design formulae.

6.2 **Strain energy:** Strain energy due to axial loads gradually applied transverse loads and under impact load.

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

**Reference books**

Objectives:
1. To prepare the students gain the insight of visualizing an object and converting it into a production drawing.
2. To impart the knowledge of conventional representation of various mechanical details.
3. To prepare the students to be conversant with 2-D and 3-D drafting using a CAD Software.

Outcomes: Learner will be able to…
1. Prepare drawings depicting interpenetration of simple solids and auxiliary views of machine parts.
2. Read and interpret detailed drawings from assembly drawings.
3. Prepare assembly drawings from detailed drawings of machine subassemblies.
4. Prepare production drawings.
5. Develop 3D models of machine parts using various CAD software’s.
6. Convert 3D models to 2D drawings using various CAD software’s.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>1.1 Solid Geometry: Intersection of surfaces and interpenetration of solids-Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views and auxiliary projections of simple machine parts. 1.2 Machine Elements: Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc.). 1.3 Conventional representation of assembly of threaded parts in external and sectional views, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Detailed and assembly drawings: 2.1 Introduction to the unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Sequence in assembly. 2.2 Preparation of details and assembly drawings of: Clapper block, Single tool post, square tool post, Lathe Tailstock.</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>Preparation of detailed and assembly drawings of Bearings: 3.1 Simple, solid, Bushed bearing, I.S. conventional representation of ball &amp; roller bearing. 3.2 Pedestal bearing &amp; footprint bearing.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>Preparation of detailed and assembly drawings of pulleys, Pipe Joints. Limits, Fits &amp; Tolerances - 4.1 Classification of Pulleys, pipe joints 4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys. 4.3 Pipe joints: Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint.</td>
<td>04</td>
</tr>
<tr>
<td>05</td>
<td>Preparation of detailed and assembly drawings of Valves, I.C. Engine parts: 5.1 Types of Valves, introduction to I.C. Engine</td>
<td>08</td>
</tr>
</tbody>
</table>
5.2 Preparation of detailed and assembly drawings of Stop valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft and Spark plug.

### Preparation of detailed and assembly drawings of Jigs and Fixtures:

6.1 Introduction to Jigs and fixtures,
6.2 Jigs and Fixtures
6.3 Reverse Engineering of a physical model: disassembling of any Physical model having not less than five parts, sketch the minimum views required for each component, measure all the required dimensions of each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions

<table>
<thead>
<tr>
<th>06</th>
<th>Preparation of detailed and assembly drawings of Jigs and Fixtures:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.1 Introduction to Jigs and fixtures,</td>
</tr>
<tr>
<td></td>
<td>6.2 Jigs and Fixtures</td>
</tr>
<tr>
<td></td>
<td>6.3 Reverse Engineering of a physical model: disassembling of any</td>
</tr>
<tr>
<td></td>
<td>Physical model having not less than five parts, sketch the minimum</td>
</tr>
<tr>
<td></td>
<td>views required for each component, measure all the required</td>
</tr>
<tr>
<td></td>
<td>dimensions of each component, convert these sketches into 3-D model</td>
</tr>
<tr>
<td></td>
<td>and create an assembly drawing with actual dimensions</td>
</tr>
</tbody>
</table>

**Term work:**

**A.** Questions from theory part of each module should be solved as home work in A-3 size sketch book, as follows :-
1. Minimum 4 questions from module 1.
3. Minimum 1 question/module from module 3 to 6.

**B.** Printouts/plots of the problems solved in practical class from the practical part of each module, as follows :-
1. 5 two dimensional detailed drawings: - Preparation of 3-D models of parts from given 2-D assembly drawing. Converting the 3-D parts into 2-D detailed drawings.
2. 5 two dimensional Assembly drawings: - Preparation of 3-D models of parts, from given 2-D detailed drawings. Assembling the 3-D parts and Converting the 3-D Assembly into 2-D assembly drawing.

Problems from practical parts of each module should be solved using standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works and Inventor etc.

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

- Homework: sketch book ........ 20 marks
- Printouts/Plots ........ 20 marks
- Attendance (theory and practical) ........ 10 marks
Practical/Oral examination:

1. Practical examination duration is of three hours, based on Part-B of the Term work, and should contain two sessions as follows:
   
   **Session-I:** Preparation of 3-D models of parts, assembling parts and preparing production drawings of these parts and assembly with appropriate tolerancing from given 2-D detailed drawings.
   
   **Session-II:** Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.
   
   *Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.*

2. Questions provided for practical examination should contain minimum five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:
   
   - **Session-I** ...... 25 marks
   - **Session-II** ...... 15 marks
   - **Oral** ...... 10 marks

4. Evaluation of practical examination to be done based on the printout of students work.

5. Students work along with evaluation report to be preserved till the next examination.

Reference Books:

2. *Machine Drawing* by P. S. Gill
### Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarize Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

### Outcomes: Learner will be able to…

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Database Concept:</strong> What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator</td>
<td>02</td>
</tr>
<tr>
<td>02</td>
<td><strong>Entity-Relationship Data Model:</strong> Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model</td>
<td>04</td>
</tr>
<tr>
<td>03</td>
<td><strong>Rational Model and Algebra:</strong> Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus</td>
<td>04</td>
</tr>
<tr>
<td>04</td>
<td><strong>Structured Query Language (SQL):</strong> Overview of SQL, Data definition commands, set operations, aggregate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries</td>
<td>04</td>
</tr>
<tr>
<td>05</td>
<td><strong>Introduction to Transactions Management and Co-currency:</strong> Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, <strong>Co-currency Control:</strong> Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging</td>
<td>04</td>
</tr>
<tr>
<td>06</td>
<td><strong>Graphical User Interface:</strong> Murphy’s law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work, <strong>Visual Programming:</strong> <strong>Sharing Data and Code:</strong> Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, using and creating ActiveX components, dynamics data exchange, Object linking and embedding, <strong>Creating visual software entities:</strong> Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces</td>
<td>06</td>
</tr>
</tbody>
</table>
Assessment:

Term Work:
Assign minimum two case studies for each student. On their case studies following exercises to be performed
1. Problem Definition and draw ER/EER diagram
2. Design Relational Model
3. Perform DDL operation
4. Perform DML and DCL operations
5. Design Forms using Visual programming
6. Retrieve the information through GUI.

Distribution of Term work Marks
Laboratory work 40 Marks
Attendance 10 Marks

End Semester Practical/Oral Examination:
1. Practical examination of 2 hours duration followed by viva to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks
   Practical examination: 40 marks
   Viva based on practical examination 10 marks
4. Students work along with evaluation report to be preserved till the next examination

Reference Books:
3. GUI Design for dummies, IDG books
5. SQL and PL/SQL for Oracle 10g, Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEL303</td>
<td>Material Testing Laboratory</td>
<td>01</td>
</tr>
</tbody>
</table>

**Objectives**

1. To familiarize the students with the use of stress, strain measuring instruments.
2. To familiarize the students with the process of metallographic sample preparation.
3. To familiarize the students with various Non-Destructive Testing methods.
4. To familiarize the students with various Heat Treatment Processes.

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

1. Conduct tensile and torsion tests on mild steel specimens.
2. Determine the Young’s modulus using deflection test on different structural specimens.
3. Prepare sample for metallographic observations.
4. Measure the hardness of given specimen.
5. Conduct NDT test on materials.
6. Perform the heat treatment processes with its relevance in the manufacturing industry.

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Experiments/Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Tensile test on mild steel rod.</td>
</tr>
<tr>
<td>02</td>
<td>Torsion test on mild steel rod.</td>
</tr>
<tr>
<td>03</td>
<td>Deflection test on steel/wood/aluminium specimen.</td>
</tr>
<tr>
<td>04</td>
<td>Charpy and Izod impact test on steel specimen.</td>
</tr>
<tr>
<td>05</td>
<td>Double shear test on steel rod.</td>
</tr>
<tr>
<td>06</td>
<td>Compression test on brick and concrete blocks.</td>
</tr>
<tr>
<td>07</td>
<td>Tension and compression test on helical springs.</td>
</tr>
<tr>
<td>08</td>
<td>Brinell and Rockwell hardness test. Sample Preparation for Metallographic observations.</td>
</tr>
<tr>
<td>09</td>
<td>Experiments based on any two NDT tests.</td>
</tr>
<tr>
<td>10</td>
<td>Experiments based on any two heat treatment methods.</td>
</tr>
</tbody>
</table>

**Term Work**

Term work shall consist of any four experiments covering the tests mentioned from sr.no 1 to 7. In all, total 7 experiments are to be performed. A detailed report, based on an Industrial visit to a manufacturing firm, covering the syllabus discussed in the subject of Material Science and Engineering needs to be submitted along with the write-up on above experiments.

Experiments (1to 7) : 10 marks
Experiments (8-10) and report on Industrial visit : 10 marks
Attendance : 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work as well as the industrial visit and minimum passing in the term work.
Course Code | Course Name                  | Credits
------------|------------------------------|--------
PEL304      | Machine Shop Practice - I   | 02     

**Objectives:**
1. To prepare the students with various lathe operations like turning, taper turning, thread cutting etc.
2. To familiarize the students with the practice of machining of flat surfaces on shaping/milling machines.
3. To prepare the students understand various concepts related to molding processes of plastic materials.

**Outcomes:** Learner will be able to…
1. Practice safe machine shop practices with working.
2. Select the right tool, set up of the machine/ job for machining.
3. Perform operations like cylindrical turning, thread cutting etc. on lathe machine.
4. Perform operations for flat surfaces like Keyway cutting, T-slot cutting etc. on shaper/miller
5. Use metals/plastics components in engineering applications.
6. Produce metal/plastic components from different manufacturing processes.

<table>
<thead>
<tr>
<th>Sr. no</th>
<th>Experiments/Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>One job on plain and taper turning.</td>
</tr>
<tr>
<td>02</td>
<td>One job on precision turning, taper turning and screw cutting.</td>
</tr>
<tr>
<td>03</td>
<td>One job on shaping/milling machine to make horizontal and inclined surfaces.</td>
</tr>
<tr>
<td>04</td>
<td>Demo of turning operation on plastic rod to know the difference in machining of metals and plastics (Any of the commercial plastics like Nylon-6, Nylon-66, Polyester, PET etc.).</td>
</tr>
</tbody>
</table>

**Term Work**

Term work shall consist of exercises as per the above List. A detailed report, based on an Industrial visit to a manufacturing firm, covering various machining practices as mentioned in the subject of Manufacturing Engineering- I, also needs to be submitted. The report should contain various machining practices followed as applicable in the industry visited.

The distribution of marks for term work shall be as follows:
- Laboratory work (4 experiments) : 40 Marks.
- Industrial visit report on Machining practises : 05 Marks.
- Attendance (practicals) : 05 Marks.
**Course Code**: MEC401  
**Course Name**: Applied Mathematics IV**  
**Credits**: 04

**Objectives:**
1. To inculcate an ability to relate engineering problems to mathematical context
2. To provide a solid foundation in mathematical fundamentals required to solve engineering problem
3. To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
4. To prepare students for competitive exams

**Outcomes:** Learner will be able to…
1. Solve the system of linear equations using matrix algebra with its specific rules
2. Demonstrate basics of vector calculus
3. Apply the concept of probability distribution and sampling theory to engineering problems
4. Apply principles of vector calculus to the analysis of engineering problems
5. Identify, formulate and solve engineering problems
6. Illustrate basic theory of correlations and regression

<table>
<thead>
<tr>
<th>Module</th>
<th>Details</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 1      | **Matrices:**  
1.1 Brief revision of vectors over a real field, inner product, norm of a vector  
1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix. Cayley Hamilton theorem (without proof). Similarity of matrices. Functions of a square matrix | 08 |
| 2      | **Matrices:**  
2.1 Minimal polynomial and Derogatory matrix  
2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors  
**Vector calculus**  
2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function  
2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral | 09 |
| 3      | **Vector calculus:**  
1.1 Green’s theorem (without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions, (No verification problems on Stoke’s Theorem and Gauss Divergence Theorem)  
**Linear Programming problems**  
1.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P | 09 |
| 4      | **Linear Programming problems Probability Distributions:**  
4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. | 09 |
**Probability Distributions**

4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance.

4.3 Probability Distributions: Binomial, Poisson and Normal Distributions

<table>
<thead>
<tr>
<th>5</th>
<th>Sampling theory:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples</td>
<td></td>
</tr>
<tr>
<td>5.2. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples.</td>
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</tr>
<tr>
<td>5.3. Student’s t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test</td>
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</tr>
</tbody>
</table>

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<tr>
<th>6</th>
<th>Sampling theory and ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1. Chi-square test, Test for the Goodness of fit, Association of attributes and Yate’s correction</td>
<td></td>
</tr>
<tr>
<td>6.2. Analysis of Variance (F-Test): One way classification, Two-way classification (short-cut method)</td>
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</tbody>
</table>

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be compulsory and should cover **maximum contents of the curriculum**
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 any module other than module 3)
4. Only **Four questions need to be solved.**

**References:**

4. Vector Analysis by Murray R. Spiegel, Shaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
9. Operations Research, Kantiswearup, Mannohan, P K Gupta, S. Chand & CO
Course Code | Course Name | Credits
---|---|---
PEC402 | Dynamics of Machines | 04

Objectives:
1. To prepare the students to understand the Mechanics of machines, principles and its application areas.
2. To familiarize the students with various types of Mechanisms and Motion analysis.
3. To develop the students with the problem solving capabilities in the topics of velocity and acceleration.
4. To familiarize the students with the kinematics and kinetics of simple machine elements and devices.
5. To provide an understanding and appreciation of the variety of mechanisms employed in modern complex machines, such as automobiles, machine tools etc.

Outcomes: learner will able to...
1. Understand the common mechanisms used in machines, correlate the concepts of kinematics with kinetics of rigid body dynamics.
2. Design of four bar mechanisms, gyroscopic devices etc.
3. Determine the velocity and acceleration of various links in motion.
4. Illustrate different types of cams, followers with their different motions for their application.
5. Develop profiles of cams for engineering applications.
6. Illustrate various types of gears/ their terminology areas of application along with parameters pertaining to spur gears and gear trains.
7. Develop basic concepts pertaining to balancing/vibrations in evaluation of simple machine components.
8. Illustrate different types of clutches, brakes and dynamometers for evaluation of braking force.

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<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Basic Concepts:</strong> Links, kinematics pairs, kinematics pairs giving one, two and three degrees of freedom, kinematics chains, degree of freedom and mobility criterion. Constrained kinematics chains as mechanism. Inversions of four bar, single and double slider crank chains and their applications, Introduction to gyroscope (no numerical problems).</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Motion Characteristics of Mechanisms:</strong> Velocity and acceleration analysis of mechanisms with single degree of freedom system with Coriollis component using graphical method. Instantaneous centre, Kennedy’s theorem; analysis of velocities of mechanism using instantaneous centre method.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>CAMS:</strong> Introduction to types of cams, types of followers. Follower motions. viz. simple harmonic motions, constant velocity, uniform and constant acceleration and retardation and cycloidal motion, layout of cam profile for specified displacement characteristics. Cams with oscillating follower systems.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>GEARS:</strong> Introduction: Types of gears and applications, Gear terminology, condition for constant velocity ratio—conjugate profiles, profiles used in gears.</td>
<td>08</td>
</tr>
</tbody>
</table>
Interference of involute teeth, methods of preventing interferences through undercutting, length of path of contact and contact ratio, no of teeth to avoid interference. Gear trains: Simple, compound, planetary and epicyclic gear trains (with numerical).

5.1 **Balancing:** Introduction. Rotary masses: several masses in same plane, several masses in different planes. Balancing of reciprocating masses, primary balancing and secondary balancing. Balancing of locomotives— Variation of Tractive Effort, Swaying Couple and Hammer blow
5.2 **Vibrations:** Introduction—free vibrations; longitudinal, transverse and torsional vibrations. Dunkerly’s equation, critical or whirling speed of shaft. Torsional vibrations of two rotor system-torsionally equivalent shaft.

**Clutches Brakes and Dynamometers:** Study and analysis of single plate clutch, multiple plate clutches and cone clutches. Types of brakes. viz. block and shoe brakes, band brake, band and block brakes, braking of vehicles. Types of dynamometers, classification, Prony brake, Rope brake belt transmission dynamometers

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- Question paper will comprise of total six questions, each carrying 20 marks
- Question 1 will be compulsory and should cover maximum contents of the curriculum
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
- Only Four questions need to be solved

**Reference Books:**
Objectives:
1. To familiarise the students with the fundamentals of molding process for metal, polymers and ceramics.
2. To familiarize the students with unconventional modern machine tools & manufacturing practices.
3. To prepare the students understand various metal joining processes and powder metallurgy.

Outcomes: Learner will be able to...
1. Illustrate the fundamentals of various non-conventional machining processes, capabilities with their application areas.
2. Demonstrate the knowledge pertaining to sheet metal fabrication/different types of joints with their trouble shooting.
3. Illustrate the concepts of various metal casting processes.
4. Demonstrate the basic knowledge of powder metallurgy Process.
5. Demonstrate the basic knowledge of plastic/ceramic molding processes.
6. Demonstrate the basic knowledge of fabrication of reinforced polymer/Polymeric composites with their applications.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Unconventional machining processes: Classification of the Non-traditional machining process. Basic principles, machines, advantage, disadvantages, and applications of Electrical discharge machining (EDM), Electron beam machining (EBM), Plasma arc machining (PAM), Laser beam machining (LBM), Electrochemical machining (ECM), Chemical machining (CHM), Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM).</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td>Types of joints: Mechanical &amp; fabricated joints. Gas, Arc welding, Resistance, Radiation, Solid state and Thermo-chemical welding processes, soldering and brazing processes, welding defects, inspection &amp; testing of welds, Safety in welding.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Mold Theory: Introduction to foundry, advantages and disadvantages. Pattern: Types, pattern making, allowances and materials. Core: types, core materials, core boxes, core sand. Molding: Types of sands, sand properties, sand control tests, sand preparation, sand molding techniques, special molding processes. Casting techniques: pressure die casting, squeeze casting, Thixo casting, Rheo Casting, investment, Shell molding and fettling. Defects and inspections.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td>4.3 Powder Metallurgy: Powder manufacturing methods; Powder Metallurgy Process. Advantages, disadvantages, and applications powder metallurgy. Case studies like Oil Impregnated Bearings.</td>
<td>08</td>
</tr>
</tbody>
</table>
| 05 | 5.1 Plastics Molding: Plastic material types, properties and processing methods.  
5.2 Ceramics Molding: Slip casting, Tape casting, Blow molding and extrusion of glass. | 08 |
| 06 | Polymeric composites manufacturing processes: Basic steps in composite manufacturing process, advantages, disadvantages of thermoset and thermoplastic composite processing. Manufacturing process for thermoset composites (applications, basic processing steps, advantages and limitations only) prepeg layup, wet layup, spray up, filament winding, pultrusion and resin transfer molding. | 08 |

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

**Reference Books:**

3. Workshop Technology Part 1, 2 and 3, W. A. J. Chapman, Taylor & Francis (1972)
10. Metal Casting: Principles And Practice by Ramana Rao
Objectives:
1. To impart the fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
2. To familiarize the students with the understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3. To prepare the students with the ability to determine energy losses due to friction and pipe fittings.
4. To prepare the students learn about various modes of heat transfer, what governs the rate of heat transfer and importance of heat transfer.
5. To impart the ability to evaluate the gas turbine and compressor performance, with a strong emphasis on T-S property plane representations.

Outcomes: Learner will be able to...
1. Illustrate the different properties of fluids along with the solution of related problems.
2. Solve problems on Bernoulli’s equation with its application.
3. Determine energy losses due to friction and pipe fittings.
4. Apply thermodynamic and fluid mechanics principles to evaluate the performance of compressors.
5. Apply thermodynamic and fluid mechanics principles to evaluate the performance of gas turbines.
6. Apply heat transfer principles to solve problems related to composite wall and heat exchangers.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Fluid Properties:</strong> Concept of fluid and flow, continuum concept, Types of fluids, Mass Density, Specific Weight, Specific Gravity, Newton’s Law of Viscosity, Dynamic Viscosity, Kinematics Viscosity, Surface Tension Capillarity, Compressibility, Vapour pressure. <strong>Fluid Statics:</strong> Pascal’s law, Pressure at a point, Hydrostatic law, Total Pressure and Centre of pressure, Hydrostatic forces on a plane (Horizontal, Vertical, Inclined) surfaces, <strong>Buoyancy and Flotation:</strong> Archimedes’ Principle, Buoyancy, Centre of Buoyancy, Metacenter, Metacentric height, Stability of floating and submerged bodies. (Only Theory on Buoyancy and Flotation)</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Fluid Kinematics:</strong> Eulerian and Lagrangian description of fluid motion, Types of fluid flow, Types of flow lines, continuity equation in Cartesian co-ordinates, Velocity potential and stream function, <strong>Fluid dynamics:</strong> Euler’s equation of motion along a stream line, Bernoulli’s equation, Application of Bernoulli’s equation to Venturi meter, Orifice meter and Pitot tube.(No derivation on rate of flow is required)</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Dynamics of Viscous Flow:</strong> Introduction to Laminar and Turbulent flow, Flow of viscous fluid in circular Pipes - Hagen Poiseuille flow. <strong>Flow Through Pipes:</strong> Major and Minor losses in pipes, Pipes in series, Pipes in parallel and Equivalent pipe.</td>
<td>08</td>
</tr>
</tbody>
</table>
**04** | **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. | **06**

**05** | **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). | **06**


**Assessment:**

**Internal Assessment for 20 marks:**
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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. **Only Four questions need to be solved**

**Reference Books:**

8. A Course in Thermal Engineering, Domkundwar, Kothoraman and Khaju
Objectives
1. To familiarize the students with different types of machines.
2. To familiarize the students with various performance curve for dc motor and induction motor.
3. To familiarize the students with various electronic switching devices.

Outcomes: Learner will be able to...
1. Illustrate the principles of operation with their main features of electric machines.
2. Develop the concepts of Electronics used in the application of controlling electrical machines.
3. Demonstrate the knowledge of Electrical and electronics engineering in processing industries.
4. Illustrate the application requirements for various types of motors
5. Demonstrate the details/applications of Transformers along with different power generation concepts.
6. Illustrate the fundamentals of Power electronics applications.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>DC Generator and DC Motor:</strong> Construction, working principle and EMF equation of dc generator, Working principle of dc motor, Types of dc motor, Torque equation, Characteristics curves, Speed control of DC motor, Starters and types 3-point starter and 4 point starters, Problems based on torque equation and speed control of dc motor.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Induction Motor(IM):</strong> Construction and working principle of three phase IM ,Torque-speed characteristics, Torque equation, Problems based on torque equation and speed-torque characteristics, Working principle of single phase induction motor, Types of single phase IM, Applications</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Stepper motor</strong> Principle of operation, Types of stepper motor, Applications of stepper motor</td>
<td>04</td>
</tr>
<tr>
<td>04</td>
<td><strong>Transformers :</strong> Single Phase, Three Phase — construction, working principle, Use of Equivalent circuit, Efficiency and Voltage regulations of transformer, Problems based on efficiency and voltage regulation</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Power system:</strong> Basic power generation concepts, Transmission system, Fuse, Circuit breakers and its types, Distribution transformers, primary distribution system, Radial distribution system, ring main distribution system</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Operational Amplifiers:</strong> OP –AMP, Characteristics of ideal OP-AMP, Comparison between ideal and practical op-amp, applications, Introduction to Boolean algebra, Boolean algebra law, Problems based on binary to decimal or octal or hexa- decimal and vice versa, logic gates, Multiplexers and de-multiplexers, Encoder and Decoders.</td>
<td></td>
</tr>
</tbody>
</table>
Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents
(approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective
lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

1. Bimbhra P.S., Electric Machinery, Khanna Publisher,
4. M H Rashid, Power electronics
5. Power system, V K Mehta.
Course Code | Course Name                     | Credits |
-------------|--------------------------------|---------|
PEL401       | Dynamics of Machines Laboratory | 01      |

Objectives:
1. To equip the students with the understanding of the fundamental principles and techniques for identifying different types of dynamic systems.
2. To prepare the students understand static and dynamic balancing of point masses.
3. To prepare the students understand as to how to determine the natural frequencies of continuous systems.
4. To familiarize the students to learn as to how to use graphical methods to compute velocity and acceleration in mechanisms.

Outcomes: Learner will be able to ….
1. Compute the natural frequencies of 1 DOF system.
2. Apply the working principles of gyroscope and Cam.
3. Demonstrate the understanding of static and dynamic balancing.
4. Compute velocity and acceleration in mechanisms.
5. Carryout Cam analysis.
6. Demonstrate the practical significance of interference and undercutting in gears.

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>List of Experiments (Any 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Gyroscope</td>
</tr>
<tr>
<td>02</td>
<td>Longitudinal Vibrations of Helical Spring</td>
</tr>
<tr>
<td>03</td>
<td>Torsional Vibrations of Shaft</td>
</tr>
<tr>
<td>04</td>
<td>Torsional Vibrations of Single Rotor System</td>
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<tr>
<td>05</td>
<td>Torsional Vibrations of Two Rotors System</td>
</tr>
<tr>
<td>06</td>
<td>Compound Pendulum</td>
</tr>
<tr>
<td>07</td>
<td>Transverse Vibrations - Whirling Speed of Shaft</td>
</tr>
<tr>
<td>08</td>
<td>Cam Analysis</td>
</tr>
<tr>
<td>09</td>
<td>Coriollic Component of Acceleration</td>
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<tr>
<td>10</td>
<td>Interference and Undercutting in Gears</td>
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</table>

(Any 2 Assignments)

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>List of Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Velocity and Acceleration Analysis</td>
</tr>
<tr>
<td>02</td>
<td>Cam and Follower</td>
</tr>
<tr>
<td>03</td>
<td>Balancing of Rotary and Reciprocating Masses</td>
</tr>
</tbody>
</table>

Term Work
Term work shall consist of the exercises listed in the above table.
The distribution of marks for term work shall be as follows:
Experiments : 10 marks
Exercises/Assignments : 10 marks
Attendance : 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Oral Examination:
1. Oral examination shall be conducted based on term work and the syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate the understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEL402</td>
<td>Fluid Mechanics and Thermal Engineering Laboratory</td>
<td>01</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To prepare the students understand Bernoulli’s theorem and study its applications.
2. To familiarize the students with the concept of stability of floating bodies.
3. To prepare the students compute Reynolds’ number and observe the laminar, transitional and turbulent flow.
4. To impart the knowledge of studying energy losses in a piping system.
5. To demonstrate the concepts discussed in the Heat Transfer course.
6. To prepare the students with the knowledge of Fourier law of heat conduction and its application.
7. To impart the students with the knowledge of working and performance of reciprocating compressors.
8. To familiarize the students with the effectiveness of heat exchangers.

**Outcomes:** Learner will be able to...
1. Apply Bernoulli’s theorem to determine the Cd / flow rate by using Orifice meter and Venturi meter.
2. Illustrate the floatation characteristics.
3. Determine metacentric height of ship model.
4. Determine critical Reynolds number for laminar, transition and turbulent flow of fluids.
5. Determine Major/Minor losses in piping systems.
6. Determine thermal conductivity and heat transfer coefficient of materials.
8. Improve effectiveness of reciprocating compressor systems.
9. Determine the emissivity of the surface.

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>List of Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>To determine the Cd of Venturi meter/ Orifice meter.</td>
</tr>
<tr>
<td>02</td>
<td>To determine Metacentric Height of Ship Model.</td>
</tr>
<tr>
<td>03</td>
<td>To Verify Bernoulli’s Theorem.</td>
</tr>
<tr>
<td>04</td>
<td>To determine types of flow by Reynolds’s Experiment.</td>
</tr>
<tr>
<td>05</td>
<td>To determine Major losses/Minor in pipes.</td>
</tr>
<tr>
<td>06</td>
<td>To determine the thermal conductivity of a given metal rod.</td>
</tr>
<tr>
<td>07</td>
<td>To determine the overall heat transfer coefficient of a composite wall.</td>
</tr>
<tr>
<td>08</td>
<td>To determine the emissivity of the given surface.</td>
</tr>
<tr>
<td>09</td>
<td>To determine LMTD for Parallel flow and Counter flow heat exchanger.</td>
</tr>
<tr>
<td>10</td>
<td>To determine the performance of single stage / multi stage air compressor test rig.</td>
</tr>
</tbody>
</table>
Term Work

Term work shall consist of at least one assignment from each module of syllabus and a minimum of 06 experiments mentioned above (minimum three experiments each from Fluid Mechanics and Thermal sections) and a detailed report based on an Industrial visit to a Thermal power plant.

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

- Laboratory work (Experiment/ programs and journal): 12 marks
- Assignments: 06 marks
- Industrial visit Report: 02 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.

Oral Examination

1. Oral examination shall be conducted based on term work and the syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate the understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.
Course Code | Course Name | Credits
--- | --- | ---
PEL403 | Electrical and Electronics Engineering Laboratory | 01

Objectives
1. To familiarize the students with different types of machines.
2. To familiarize the students with the various performance curve for dc motor and induction motor.
3. To familiarize the students with various electronic switching devices.

Outcomes: Learner will be able to...
1. Identify the principles of operation along with features of electric machines.
2. Develop the concepts of Electronics used in controlling electrical machines.
3. Use their knowledge of Electrical and electronics engineering in processing industries.
4. Understand and comprehend application requirements for various types of motors.
5. Use different power generation concepts.
6. Demonstrate the fundamentals of Power electronics applications in industry.

<table>
<thead>
<tr>
<th>Exp. No.</th>
<th>List of Experiments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Speed control of dc shunt motor.</td>
</tr>
<tr>
<td>02</td>
<td>Load characteristics of series generator.</td>
</tr>
<tr>
<td>03</td>
<td>Load characteristics of 3phase induction motor.</td>
</tr>
<tr>
<td>04</td>
<td>No-load and blocked rotor test of induction motor.</td>
</tr>
<tr>
<td>05</td>
<td>Integrator and differentiator using op-amps.</td>
</tr>
<tr>
<td>06</td>
<td>Multiplexer and DE multiplexer.</td>
</tr>
<tr>
<td>07</td>
<td>SCR characteristics curve.</td>
</tr>
<tr>
<td>08</td>
<td>TRIAC characteristics curve</td>
</tr>
<tr>
<td>09</td>
<td>Logic gates.</td>
</tr>
<tr>
<td>10</td>
<td>Hartley oscillators.</td>
</tr>
</tbody>
</table>

Term Work
Term work shall consist of any seven experiments from sr.no 1 to 10. In all total 9 experiments.

Experiments (1to 10) : 10 marks
Assignments : 10 marks
Attendance : 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Objectives:
1. To prepare the students practice machining of flat surfaces on shaping and grinding machines.
2. To impart the practical knowledge of milling, boring and thread cutting operations.

Outcomes: Learner will be able to:
1. Perform machining of composite jobs involving different operations.
2. Apply significance of maintaining tolerance level during machining to facilitate assembly requirement.
3. Practice basic understanding of safe machine shop practices and safe working.
4. Select the right tool and set up the machine, job and tool for machining practices.
5. Demonstrate practical aspects involved in operation and applications of milling, shaping, grinding, boring etc.

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Experiments/Job</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>One assembly job employing operations on lathe, precision turning, screw cutting, boring etc. and involving the use of shaping, milling and grinding operations.</td>
</tr>
<tr>
<td></td>
<td>OR</td>
</tr>
<tr>
<td></td>
<td>One job on any unconventional machining process.</td>
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<tr>
<td>02</td>
<td>Demo on machining of Glass Fibre Reinforcement Plastic (GFRP) composite material, Drilling and edge milling operation are to be studied (Any of the commercial available GFRP/Epoxy plates are to be used).</td>
</tr>
</tbody>
</table>

Term Work:
Term work shall consist of exercises as per the above List. A detailed report, based on an Industrial visit to a manufacturing firm, covering the practical aspects of syllabus mentioned in the subject of Manufacturing Engineering- II also needs to be submitted.

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

- Laboratory work (Assembly Job) : 30 marks
- Demo on machining of Composite material : 10 marks
- Industrial Visit Report : 05 Marks.
- Attendance (practicals) : 05 Marks.

Practical Examination:
Practical examination will be held for 4 hours and shall consist of a job containing a minimum of 4 operations including precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.
Objectives
1. To prepare the students study and analyze casting and forming processes like forging, rolling, extrusion and drawing of ferrous and non-ferrous metals.
2. To familiarize the students with the design of sand molds, die casting dies, roll grooves and multi impression forging die etc.

Outcomes: Learner will be able to...
1. Demonstrate the concepts of metal casting and metal forming processes.
2. Identify the equipment, machinery and tooling used for sand casting/die casting.
3. Identify equipment, machinery and tooling used for forming processes (such as forging, rolling and extrusion).
4. Illustrate the basic theory pertaining to plastic deformation of metal.
5. Develop skills in designing tools, the set up for the processing techniques pertaining to various metal casting and metal forming operations.
6. Analyze various defects, their probable causes and remedial measures confronted with metal casting and forming processes.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Design of Sand moulds:</strong></td>
<td></td>
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<tr>
<td></td>
<td>1.1 Design and drawing of gating system: Pouring basin, Sprue, Runners and Ingates.</td>
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<tr>
<td></td>
<td>1.2 Design of feeding system: Caine’s method, Modulus method, Chvorinov’s mould constant, Use of chills, padding and risering.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>2.1 Melting &amp; Pouring: Melting practices: Cupola, Arc and Induction furnaces.</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>2.2 Defects in cast components and their remedies.</td>
<td></td>
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<tr>
<td>03</td>
<td><strong>Special Casting Processes</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Casting process used for composites.</td>
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<tr>
<td></td>
<td>2.3 Defects in die cast components and their remedies.</td>
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<tr>
<td></td>
<td>2.4 Lost Wax Process Investment Casting: Use of wax as the moulding material; Process description; Features and advantages; Fields of application;</td>
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<tr>
<td></td>
<td>2.5 Shell Mould casting: Working principle and application.</td>
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<tr>
<td>04</td>
<td><strong>Forging of metals</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 Forging hammers, high speed forging machines, Presses and Horizontal upset forging machines: Construction and principle of operation.</td>
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<td></td>
<td>4.2 Single and multi-impression closed die forging process;</td>
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<tr>
<td></td>
<td>4.3 Design and drawing of multi-impression drop forging, die set using fuller, edger, bender, blocker and finisher, cavities with flash and gutter.</td>
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<tr>
<td></td>
<td>4.4 Defects in forged products and their remedies.</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td><strong>Rolling of metals</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.1 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.</td>
<td></td>
</tr>
</tbody>
</table>
5.2 Production of seamless tubes by rolling.
5.3 Defects in rolled products and their remedies.

<table>
<thead>
<tr>
<th>06</th>
<th>Extrusion of Metals and Miscellaneous Metal Forming Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>6.1 Introduction to metal extrusion and basic concepts of extrusion dies.</td>
</tr>
<tr>
<td>06</td>
<td>6.2 Drawing of metals: Principle of operation and applications.</td>
</tr>
</tbody>
</table>

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents
(approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective
lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

**Reference Books:**

6. Die Casting, H.H. Doehler
8. Mechanical Metallurgy, George E. Dieter.
11. Forging Handbook-Forging Methods, A. Thomas, Publisher-Drop Forging Research
Association, Shepherd Street, Sheffield.
### Course Code | Course Name | Credits
--- | --- | ---
PEC502 | Operations Research | 03

**Objectives:**
1. To familiarize the students with various tools of optimization for management of various resources.
2. To acquaint the students with various simulation tools for optimization for various resources.

**Outcomes:** Learner will be able to:
1. Utilize the resources in various industries optimally.
2. Apply the concept of linear programming for solving specialized problems on transportation, assignments & sequencing.
3. Apply principles of queuing, replacement & game theory models to solve real life problems.
4. Demonstrate the concept of dynamic programming in modelling and solving problems.
5. Illustrate different types of simulation models applicable to Inventory/queuing.
6. Acquire skills in identifying & applying cost effective strategies in managing of manufacturing projects.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 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. | 15 |
| 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 | 05 |
| 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 levelling. | 08 |
**Assessment:**

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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 any module other than module 3)
4. Only **Four questions need to be solved**

**Reference Books:**
### Course Code: PEC503
#### Course Name: Machine Design – I
#### Credits: 04

**Objectives:**
1. To prepare the students learn basic principles of engineering design.
2. To familiarise the students with the concepts of strength design related to various components.
3. To acquaint the students use design data books & various codes of practices.

**Outcomes:** Learner will be able to:
1. Apply basic principles of machine design.
2. Design joints such as knuckle joint/turn buckle.
3. Design machine elements such keys, shafts, couplings/springs.
4. Design pressure vessels.
5. Design weld joint.
6. Design rivet/bolt joints.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>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. <strong>Operational Joints</strong> - Introduction to cottered, pinned &amp; threaded joints, &amp; their applications. 1.3. Design of socket &amp; spigot type 1.4. Design of Pinned Joints - Knuckle joint 1.5. Design of Turn Buckle</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>2.1 Determination of stresses in machine components with various cross sections. Circular, rectangular, triangular, trapezoidal, T &amp; I sections subjected to direct &amp; bending stresses. (Including stresses at critical sections) 2.1. Stresses in curved members- Design of crane hooks &amp; C-clamps with various cross sections (Circular, triangular, square, rectangular, trapezoidal) (Circular &amp; oval rings to be excluded).</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td>3.1. <strong>Design of shafts</strong> 3.1.1. Design of shafts on the basis of strength. Shafts subjected to-bending alone, Torsion alone, combined action of torsion &amp; bending, combined action of torsion &amp; axial loads, combined action of torsion, bending &amp; axial loads (Rankine’s and Guest’s equations) 3.1.2. Concepts about design of shafts based on rigidity (lateral &amp; torsional rigidity)- only Implications 3.2. <strong>Design of keys</strong> 3.2.1. Different types of keys and applications. 3.2.2. Fitting of keys – types and effects of keyway on shaft 3.2.3. Stresses in keys and design of key dimensions. 3.3. <strong>Design of couplings:</strong> 3.3.1. Classification of couplings &amp; application areas.</td>
<td>10</td>
</tr>
</tbody>
</table>
3.3.2. Design of flanged couplings, muff couplings, bushed pin type flexible coupling.

4.2. Design of welded joints subjected to eccentric loading. |
|---|---|
| 05 | 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 riveted joints**- Type of rivets and riveted joints. Failure modes of riveted joints & efficiency of riveted joints. Design of riveted joints for riveting longitudinal & circumferential seams of pressure vessels. Familiarization of Indian Boiler Regulation (IBR)  
5.3. **Design of bolted and riveted joints** subjected to eccentric loading. |
| 06 | 6.1. **Design of Springs**: Classification and applications, design of helical compression and tension springs (only circular cross-section), 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. |

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4. Only **Four questions need to be solved**

**NOTE:**  
Use of standard design data books like PSG Data Book or Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.
Reference Books:

6. Recommended Data Books - PSG, K. Mahadevan
7. Machine Design - Reshetov - Mir Publication
10. Design of Machine Elements - V.M. Faires
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>PEC504</td>
<td>CAD/CAM/CIM</td>
<td>04</td>
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</table>

**Objectives:**
1. To familiarize the concepts of computer aided engineering for design & manufacturing.
2. To impart the knowledge on computer graphics used in engineering.
3. To familiarize the students with the concepts of computer aided manufacturing and its significance.
4. To familiarize the students with interfacing of drive systems with the machines.

**Outcomes:** Learner will be able to...
1. Use computer graphics in design.
2. Identify proper modeling techniques for geometric modeling.
3. Develop expertise in computer-aided manufacturing.
4. Illustrate basic concepts of control systems.
5. Write the appropriate code for performing particular tasks in a CNC.
6. Solve real life engineering problems using FEA.

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<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</td>
<td>Computer Aided Design:</td>
<td></td>
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<tr>
<td></td>
<td>1.1 <strong>Introduction</strong> : Need and Utility of CAD systems in industry, Product Cycle, Definition of CAD tools based on their Constituents and Implementation in a design environment.</td>
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<tr>
<td></td>
<td>1.2 <strong>CAD Hardware</strong> : Types of systems, system considerations, I/O devices, Hardware Integration &amp; Networking.</td>
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<tr>
<td></td>
<td>04</td>
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<tr>
<td>02</td>
<td>Computer Graphics :</td>
<td></td>
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<tr>
<td>03</td>
<td>Solid Modeling :</td>
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<td></td>
<td>Types of representation of solid models, interactive tools available with solid modeling software’s. Introduction to surface modeling.</td>
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<td></td>
<td><strong>CAD DATA Exchange</strong> : File Structure and format of IGES,STEP and DXF</td>
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<td>05</td>
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<td>04</td>
<td>Introduction :</td>
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<tr>
<td></td>
<td>Elements of CAM system, Computer Numerical control of Machine Tools, Fundamental elements of CNC, Benefits of CNC, Computer control concepts, Data processing units &amp; Binary calculation.</td>
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<td></td>
<td><strong>Basics of control systems:</strong></td>
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<td></td>
<td>Motion controller, Interpolation-Linear &amp; Circular, Positioning &amp; contouring control loops, Incremental &amp; Absolute system, DNC &amp; CNC systems and Adaptive control system.</td>
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<td></td>
<td><strong>CNC Hardware Basics:</strong></td>
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<td></td>
<td>CNC drives, Spindle design, Actuation and Feedback devices</td>
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<td>10</td>
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</tbody>
</table>
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.

CIM:
Computer applications in manufacturing, Automation and Integrated Production management systems. Automated Material handling systems, Conveyors, AVG, AS/RS, GT, FMS, Automated inspection procedure, Distributed Numerical control & Benefits of CIM and implementation & computer aided shop floor control system. Concept of “Ghost” factory.

FEA:

Assessment:

Internal Assessment for 20 marks:
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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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4. Only Four questions need to be solved

Reference Books:
1. CAD/CAM by Groover and Zimmers
2. CAD Principles and Applications by Barr, Krimger and Lazaer
8. CAD / CAM by P.N. Rao (Tata-Mcgraw- Hill) 2
9. *Mathematical and Procedural Elements for computer graphics* by Roger and Adams
11. *A first course in FEM* by daryl L.Logon(Cengage) 3
12. *Concepts and applications of FEA* by Cook, Malkus (Jhon-wiley)
13. *Mastering CAD – CAM* by Ibarahim Zeid (Tata-Mcgraw-Hill) 4
Course Code | Course Name                    | Credits
------------|--------------------------------|-------
PEC505      | METROLOGY AND QUALITY ENGINEERING | 04    

Objectives:
1. To acquaint with principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment’s.
3. To acquaint with key features and the basics of Total Quality Management philosophy.
4. To familiarize with various quality tools and their uses in solving problems.

Outcomes: Learner will be able to…
1. Handle & operate precision measuring instruments / equipment’s.
2. Design Go and No Go gauges for a given assembly.
3. Analyze simple machined components for dimensional stability & functionality.
4. Identify and use proper quality tools in various manufacturing /service problems.
5. Integrate quality approaches for productivity improvement.
6. Comprehend and apply Quality standards in different situations.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
</tr>
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</table>
| 01     | **1. Introduction to Metrology**  
1.1 Need for inspection, fundamental principles and definition, standards of measurement, Static characteristics of Measurements.  
1.2 Limits, fits and Tolerances of interchangeable manufacture, Elements of Interchangeable System, hole based and shaft based systems IS 919 : 1963 tolerance grades, types of fits, General requirements of go & NO Go gauging, Taylor’s principle, Design of go & no go gauges. |
| 02     | **2.1 Comparators**: Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field of Applications.  
**2.2 Principles of interference**, concept of flatness, flatness testing, optical flats, optical Interferometer and laser interferometer.  
**2.3 Surface texture measurement**: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols |
| 03     | **3.1 Screw Thread measurement**: Two wire and three wire methods, floating carriage micrometer.  
**3.2 Gear measurement**: Gear tooth comparator, Master gears, measurement using rollers and Parkinson’s Tester.  
**3.3 Special measuring Equipment**: Principles of measurement using Tool Maker’s microscope, profile projector & 3D coordinate measuring machine. |
| 04     | **Quality**  
**1.1 Quality Control**  
Evolution of Quality, Definition of Quality, Dimensions of Quality Planning, Principles of TQM, set up policy and objectives of quality control, quality of
design and quality of conformance, compromise between quality & cost, quality cost and planning for quality

**1.2 Cost of quality**: prevention, appraisal & failure costs and Hidden cost of quality.

**1.2 Quality improvement**


**SQC and SQC 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).

**5.6 Sampling Techniques** Sampling inspection and basic concepts, OC curves, consumer & Producer risk, single & double sampling plans and use of sampling tables.

**6.2 Quality standards**

c. ISO 27001:2005 Information Security Management System
d. ISO/TS 16949:2002 for Automobile Industry
e. Internal audit, surveillance audit, maintaining of certification

**Assessment:**

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4. Only Four questions need to be solved
Reference Books:

8. *Introduction to Statistical Quality Control*, By Douglas C. Montgomery wiley india publication
11. *Metrology for Engineers* Charles Reginald Shotbolt, PublisherCassell,
Course Code | Course Name | Credits
---|---|---
PEDLO5011 | Internal Combustion Engines | 03

Objectives:
1. To familiarize with various types of internal combustion engines.
2. To impart knowledge about various systems/components of IC engines.
3. To impart knowledge about various engine performance characteristics and its testing.

Outcomes: Learner will be able to:-
1. Demonstrate working of different types of engines.
2. Analyze fuel supply systems and ignition systems of IC Engines.
3. Distinguish combustion process of SI and CI Engines.
4. Measure operating characteristics of IC Engines.
5. Analyze the impact of vehicular pollution and ways to reduce or control the pollution.
6. Illustrate various standard pollution norms like EURO, Bharat for I.C. engines.

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<td>01</td>
<td>Introduction to IC Engines and cycle analysis: Basic of I.C. Engines, Details of two stroke and four stroke engines, Valve timing diagram, Air standard cycles, Fuel air cycle and actual cycle. Variation in specific heat, Dissociation and their effect on engine performance. Review of other losses in IC engines.</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td>Compression Ignition Engines Fuel supply system in CI Engine: Air injection systems, Airless/solid injection systems, individual pump, Common rail and distributor system, unit injector etc, types of fuel pump, injector and nozzles. Electronically controlled fuel injection system Combustion in compression ignition engines (CI): Stages of combustion, ignition delay, factors affecting delay period, phenomenon of knocking in CI engine, effect of engine variables on knocking, comparison of knocking in SI &amp; CI engines, types of combustion chambers, rating of fuels in CI engines,</td>
<td>07</td>
</tr>
<tr>
<td>04</td>
<td>Engine systems and components Engine lubrication : Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems</td>
<td>07</td>
</tr>
</tbody>
</table>

University of Mumbai, B. E. (Production Engineering), Rev 2016 59
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<tr>
<th><strong>Engine Cooling</strong></th>
<th>Necessity of engine cooling, disadvantages of overcooling. Cooling systems and their comparison: Air cooling, Liquid cooling. <strong>Supercharging/Turbo-charging</strong></th>
<th>Objectives, Effects on power output and engine efficiency, Methods, Types and Limitations.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engine Emission and Control</strong></td>
<td>S.I. engine emission (HC, CO, NOx) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- Chemical, EGR. Standard pollution norms like EURO, Bharat, Introduction to alternative fuels for I.C. engines,</td>
<td>06</td>
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4. Only Four questions need to be solved

**Reference Books:**

2. *Internal Combustion Engines*, by Shyam Agrawal, New Age International
3. *Internal Combustion Engines*, by Mathur and Sharma
5. *Internal Combustion Engines*, by Gills and Smith
7. *Internal Combustion Engines*, by Gupta H N, 2nd ed, PHI
8. *Internal Combustion Engines*, by Richard Stone - Palgrave Publication
9. *Internal Combustion Engines*, by Domkundwar
10. *Internal Combustion Engines*, by V. Ganeshan
Objectives
1. To introduce the concepts of Mathematical Modelling of Engineering Problems.
2. To familiarize with the applicability of FEM to a range of Engineering Problems.
3. To acquaint with the applications of numerical techniques for solving problems.

Outcomes: Learner will be able to…
1. Solve ordinary and partial differential equations using the Galerkin method.
2. Develop the finite element equations to model engineering problems governed by 2nd order partial differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems.
4. Use commercial FEA software, to solve problems related to engineering.
5. Prepare Solutions of 2 -D Problems using FE Software.
6. Find solution techniques to Dynamic problems, longitudinal vibration, frequencies and mode shapes.

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<tr>
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<tr>
<td>01</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1. Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM.</td>
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<tr>
<td></td>
<td>1.3 Approximate solution of differential equations-- Weighted residual techniques, Galerkin methods.</td>
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<tr>
<td></td>
<td>FEA Procedure</td>
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<tr>
<td></td>
<td>2.1 Discrete and continuous models, Weighted Residual Methods –Ritz Technique –Basic concepts of the Finite Element Method.</td>
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<tr>
<td></td>
<td>2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables, boundary conditions.</td>
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<tr>
<td>03</td>
<td>One-Dimensional Problems</td>
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<tr>
<td></td>
<td>3.2. Assembly of Matrices -solution of problems in one dimensional structural analysis, heat transfer and fluid flow (Stepped and Taper Bars, Fluid Network, Spring-Cart systems)</td>
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<td></td>
<td>3.3. Analysis of Plane Trusses, Analysis of Beams.</td>
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<td>3.4. Solution of one Dimensional structural and thermal problems using FE Software, Selection of suitable Element Type, Modeling, Meshing,</td>
<td></td>
</tr>
</tbody>
</table>
Boundary Condition, Convergence of solution, Result analysis, Case studies.

| 04 | **Two Dimensional Finite Element Formulations**  
|    | 4.1 Introduction, Three nodded triangular element, four nodded rectangular element, four nodded quadrilateral element.  
|    | 4.2 Natural coordinates and coordinates transformations: serendipity and Lagranges methods for deriving shape functions for triangular and quadrilateral element  
|    | 4.3. Introduction to Sub parametric, Isoperimetric, super parametric elements. Compatibility, Patch Test, Convergence criterion, Sources of errors. | 08 |

| 05 | **Two Dimensional Vector Variable Problems**  
|    | 5.1 Equations of elasticity – Plane stress, plane strain and axisymmetric problems.  
|    | 5.2. Jacobian matrix, stress analysis of CST.  
|    | 5.3. Solution of 2-D Problems using FE Software (structural and Thermal), election of element type, meshing and convergence of solution. (Can be covered during practical hours). | 05 |

| 06 | **Finite Element Formulation of Dynamics and Numerical Techniques:**  
|    | 6.1. Applications to free vibration problems of rod and beam. Lumped and consistent mass matrices.  
|    | 6.2. Solutions Techniques to Dynamic problems, longitudinal vibration, frequencies and mode shapes. Fourth Order Beam Equation, Transverse deflections and Natural frequencies of beams.  
|    | 6.3 Finding frequencies of beam using FE Software (Can be covered during practical hours). | 05 |

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4. Only Four questions need to be solved
Reference Books:

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

### Outcomes: Learner will be able to…
1. Illustrate the various applications of plastics.
2. Demonstrate applicability of plastics in place of conventional materials.
3. Design various tools for plastics processing.
4. Illustrate various plastic processing techniques.
5. Design different types of moulds with their application.
6. Demonstrate trouble shooting skills in manufacturing plastic parts.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Materials</strong>&lt;br&gt;Brief introduction to plastics materials, their classifications, types important properties &amp; fields of application. Introduction to plastics blends, alloys and composites. Principles of recycling of plastics and waste management</td>
<td>04</td>
</tr>
</tbody>
</table>
| 03 | **Auxiliary equipment for plastics processing**
Hopper dryers, Deccant 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. |
| 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 Processes. |
| 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 auxiliary 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. |
| 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. |

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

1. Moulding of Plastics, Bickales.
2. Design of Extrusion dies, M. V. Joshi.
5. Extrusion Technology – Allen Griff.
8. Handbook of Composite fabrication, Akovali.
Objectives:
1. To familiarize with the applications of various Micro and Nano manufacturing technologies.
2. To familiarize with traditional Micro and Nano machining.
3. To familiarize with Non-traditional Micro machining methods.
4. To familiarize with Micro Forming and Welding techniques.
5. To familiarize with various processes used for Nano finishing and carbon nano tube production.

Outcomes: Learner will be able to...
1. Demonstrate understanding of various traditional/non-traditional micro and nano machining methods.
2. Demonstrate understanding of various micro forming/welding techniques.
3. Demonstrate understanding of various nano finishing/carbon nano tube production methods.
4. Illustrate the details of various Micro Forming and Welding techniques.
5. Demonstrate various Nano Finishing Techniques used in industries.
6. Illustrate various Carbon Nanotube Production processes applicable in industries.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Overview of Micro and Nano Manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction, Micro-Products And Design Considerations For Manufacturing, Material Factors, Considerations On Manufacturing Methods, Manufacturing Methods And Processes, Process Chains And Hybrid Processes, Transition from Nanotechnology to Nano manufacturing.</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td>Traditional Micro and Nano Machining</td>
<td></td>
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<tr>
<td></td>
<td>Theoretical basis of Nano machining</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cutting force and energy, Cutting temperature, Chip formation and surface generation, Minimum undeformed chip thickness, Critical cutting edge radius, Properties of workpiece materials, Comparison of nanometric machining and conventional machining, Implementation of nanomachining - single point diamond turning.</td>
<td>12</td>
</tr>
<tr>
<td>03</td>
<td>Non-traditional Micro Machining</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultra Sonic Micro Machining, Chemical and Electro Chemical Micro Machining, Electric Discharge Micro Machining, Electron Beam Micro Machining, Laser Beam Micro Machining, Ion Beam Micro Machining.</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td>Micro Forming and Welding</td>
<td>06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nano Finishing Techniques</th>
<th>05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasive Flow Machining (AFM), Magnetic Abrasive Finishing (MAF), Magneto rheological Finishing (MRF), Magneto rheological Abrasive Flow Finishing (MRAFF), Magnetic Float Polishing (MFP), Elastic Emission Machining (EEM), Chemical Mechanical Polishing (CMP).</td>
<td>06</td>
</tr>
</tbody>
</table>

Carbon Nanotube Production

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

## Objectives

1. To introduce basic concepts related to sustainability and sustainable development.
2. To get conversant with indigenous and global concerns about sustainability and its implications in manufacturing.
3. To familiarize with various technological innovations, approaches & environmental standards /legislations to promote sustainable development.

## Outcomes: Learner will be able to…

1. Illustrate the agenda of indigenous and global sustainability to fulfil green expectations.
2. Demonstrate the knowledge about management of waste, pollution & energy conservation.
3. Demonstrate the knowledge of sustainability issues with its implementation in manufacturing.
4. Illustrate the relevance and implications of environment friendly materials.
5. Illustrate the implications of environment management in the context of modern industrial practices.
6. Develop the sustainability approach in environmental strategy and manufacturing.

## Module Contents

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Sustainability</strong>: Basic concepts related to sustainability and sustainable development. Issues and challenges facing sustainable development. Global &amp; indigenous sustainability agenda, green expectations &amp; green movement.</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td><strong>Management of waste &amp; pollution</strong>: Types, sources and nature of wastes, waste processing, green processing &amp; engineering operations, Energy recovery, and 3 R principle. Types of pollution and management:-Anti pollution approaches &amp; guide lines.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Management of Energy</strong>: Sources of energy, renewable energy, Innovations in generation, conservation, recycling and usage of energy. Energy audit and implications.</td>
<td>07</td>
</tr>
<tr>
<td>05</td>
<td><strong>Environment Management</strong>: Innovations for reuse, bio-processing technology, sustainable loading on ecosystems, concept of eco-efficiency and its implementation, Environment analysis from raw materials to disposal (cradle to grave concept) sustainable design and materials for sustainable design, Environmental standards and legislations. ISO 14000, carbon foot print, anti-pollution boards, Environment management in business world, changing scenario in global perspective.</td>
<td>08</td>
</tr>
</tbody>
</table>
06  Integrating sustainability approach: Environmental issues in operating strategy, creating sustainable manufacturing, promoting sustainability awareness, sustainability rating schemes, eco-labelling programmes, human values and professional ethics in sustainable manufacturing. Encouraging innovations in sustainable manufacturing.

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

3. Advances in sustainable Manufacturing By Gunther Seliger and Marwan M.K. khraishah, Springer Series
6. Sustainable Development By M.K. Ghosh Roy Ane Books Pvt.Ltd,
Objectives
1. To prepare a study on sand moulds and pressure die casting dies.
2. To prepare a study on multi impression forging dies and roll passes.
3. To prepare a study on design & draw sand moulds and die casting dies.
4. To prepare a study on design & draw multi impression forging dies and roll pass grooves.

Outcomes: Learner will be able to…
1. Illustrate various forming and casting processes used in manufacturing of components.
2. Classify the equipment’s and machines used in manufacturing processes, such as casting, rolling, forging, extrusion and wire drawing.
3. Design and draw the moulds required for castings/ pressure die casting processes.
4. Design and draw the dies required for forging processes.
5. Design and draw the grooves required for rolling processes.
6. Demonstrate various trends in the foundry/forging industries.

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Design Exercise/Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Assignment on Sand casting</td>
</tr>
<tr>
<td>02</td>
<td>Assignment on Special casting process.</td>
</tr>
<tr>
<td>03</td>
<td>Assignment on Extrusion process.</td>
</tr>
<tr>
<td>05</td>
<td>Design of sand casting moulds.</td>
</tr>
<tr>
<td>06</td>
<td>Design of Pressure die casting dies.</td>
</tr>
<tr>
<td>07</td>
<td>Design of Forging dies.</td>
</tr>
<tr>
<td>08</td>
<td>Design of Roll pass grooves.</td>
</tr>
</tbody>
</table>

Term Work
Term work shall consist of exercises listed in the above table and also a detailed report based on an Industrial visit to a Casting/Forging plant.
The distribution of marks for term work shall be as follows:
Assignments : 07 marks
Industrial visit Report : 03 marks
Design Exercises with Drawings (scaled model) on A4 size : 15 marks
Attendance : 05 marks

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

Oral Examination
1. Oral examination shall be conducted based on term work and syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEL502</td>
<td>Machine Design – I Laboratory</td>
<td>01</td>
</tr>
</tbody>
</table>

**Objectives**

1. To familiarize with basic principles of engineering design and design various machine components.
2. To familiarize with the use of design data books & various codes of practice.
3. To familiarize with the preparation of working drawings based on designs.

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

1. Demonstrate various design considerations.
2. Apply basic principles of machine design.
3. Design machine elements.
4. Use design data books and various standard codes of practices.
5. Prepare drawings pertaining to various designs.
6. Design various joints used in engineering applications.

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Design Exercises/ Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Design of Curved Beams</td>
</tr>
<tr>
<td>02</td>
<td>Design of Bolted, Welded and Riveted Joints</td>
</tr>
<tr>
<td>03</td>
<td>Design of Springs and Pressure Vessels</td>
</tr>
<tr>
<td>04</td>
<td>Design of Socket and Spigot type Cotter Joint, Knuckle Joint, Turnbuckle (Any Two)</td>
</tr>
<tr>
<td>05</td>
<td>Design of Shafts (Two Design Problems)</td>
</tr>
<tr>
<td>06</td>
<td>Design of Rigid Flange Coupling, Bush Pin Type of Flexible Coupling</td>
</tr>
</tbody>
</table>

**Term Work**

Term work shall consist of exercises listed in the above list.

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

- Assignments: 10 marks
- Design Exercises with Drawings on A4 size Paper: 10 marks
- Attendance: 05 marks

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

**Oral Examination**

1. Oral examination shall be conducted based on term work and syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.
Objectives
1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcomes: Learner will be able to…
1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects as well as store and manage data.
3. Create CAM Toolpath and prepare NC- G code
4. Apply rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises
1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work
Term work shall consist of
a. Any four exercises from 1 to 6 of above list
b. Part programming and part fabrication on CNC trainer
c. A course project in a group of not more than four students based on 8 and 9 of above list

The distribution of marks for term work shall be as follows:
- Exercises : 15 Marks
- Course Project : 05 Marks
- Attendance : 05 Marks

Assessment:
End Semester Practical/oral Examination:
1. Each student will be given a small task of design based on syllabus, which will be assessed by pair of examiners during the oral examination.
2. Distribution of marks for practical/oral examination shall be as follows:
   - Design Task: 15 marks
   - Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination
Objectives
1. To acquaint with the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments / equipments.
3. To acquaint with key features and basics of the Total Quality Management philosophy.
4. To familiarize with various quality tools and their uses in solving the problems.

Outcomes: Learner will be able to…
1. Handle & operate precision measuring instruments /equipment’s.
2. Measure linear and angular measurements.
3. Measure thread and gear dimensions.
4. Design Go and Not Go gauge for given assembly.
5. Analyze simple machined components for dimensional stability & functionality.
6. Use proper quality tools in various manufacturing /service problems.
7. Use appropraite quality approaches for productivity improvement.
8. Comprehend and apply Quality standards in different situations.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Experiments/Assignments</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Any Five experiments</strong></td>
</tr>
<tr>
<td>01</td>
<td>Use of linear and angular measuring instruments</td>
</tr>
<tr>
<td>02</td>
<td>Use of Profile projector.</td>
</tr>
<tr>
<td>03</td>
<td>Use of comparator.</td>
</tr>
<tr>
<td>04</td>
<td>Measurement of surface roughness.</td>
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<tr>
<td>05</td>
<td>Measurement of flatness.</td>
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<tr>
<td>06</td>
<td>Thread measurement.</td>
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<tr>
<td>07</td>
<td>Gear measurement.</td>
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<tr>
<td></td>
<td><strong>Assignment on any Six assignments</strong></td>
</tr>
<tr>
<td>01</td>
<td>Limits, Fits, Tolerance and Gauge Design.</td>
</tr>
<tr>
<td>02</td>
<td>Comparators and Interferometers</td>
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<tr>
<td>03</td>
<td>Surface Roughness Measurement.</td>
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<tr>
<td>04</td>
<td>Thread Measurement</td>
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<tr>
<td>05</td>
<td>Gear Measurement</td>
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<tr>
<td>06</td>
<td>Total Quality Management</td>
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<td>07</td>
<td>Statistical Quality Control</td>
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<tr>
<td>08</td>
<td>Quality Standards</td>
</tr>
</tbody>
</table>
Term Work
Term work shall consist of at least 1 assignment on each module from syllabus and minimum 05 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.

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:
   a. Practical performance …… 15 marks
   b. Oral …… …………………….10 marks
4. Students work along with evaluation report to be preserved till the next examination.
**Subject Code**: PEL505  
**Subject Name**: Business Communication & Ethics  
**Credits**: 02

**Objectives:**
1. To inculcate professional and ethical attitude at the workplace
2. To enhance effective communication and interpersonal skills
3. To build multidisciplinary approach towards all life tasks
4. To hone analytical and logical skills for problem-solving

**Outcomes:** Learner will be able to...
1. Design a technical document using precise language, suitable vocabulary and apt style.
2. Develop the life skills/interpersonal skills to progress professionally by building stronger relationships.
3. Demonstrate awareness of contemporary issues knowledge of professional and ethical responsibilities.
4. Apply the traits of a suitable candidate for a job/higher education, upon being trained in the techniques of holding a group discussion, facing interviews and writing resume/SOP.
5. Deliver formal presentations effectively implementing the verbal and non-verbal skills

<table>
<thead>
<tr>
<th>Modules</th>
<th>Detailed Content</th>
<th>Hours</th>
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<tbody>
<tr>
<td>01</td>
<td>Report Writing</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td>1.1 Objectives of Report Writing</td>
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<tr>
<td></td>
<td>1.2 Language and Style in a report</td>
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<td></td>
<td>1.3 Types: Informative and Interpretative (Analytical, Survey and Feasibility) and Formats of reports (Memo, Letter, Short and Long Report)</td>
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<tr>
<td>02</td>
<td>Technical Writing</td>
<td>03</td>
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<tr>
<td></td>
<td>2.1 Technical Paper Writing (IEEE Format)</td>
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<td></td>
<td>2.2 Proposal Writing</td>
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<tr>
<td>03</td>
<td>Introduction to Interpersonal Skills</td>
<td>09</td>
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<tr>
<td></td>
<td>3.1 Emotional Intelligence</td>
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<td>3.2 Leadership and Motivation</td>
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<td></td>
<td>3.3 Team Building</td>
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<td>3.4 Assertiveness</td>
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<td></td>
<td>3.5 Conflict Resolution and Negotiation Skills</td>
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<td></td>
<td>3.6 Time Management</td>
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<td></td>
<td>3.7 Decision Making</td>
<td></td>
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<tr>
<td>04</td>
<td>Meetings and Documentation</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>4.1 Strategies for conducting effective meetings</td>
<td></td>
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<tr>
<td></td>
<td>4.2 Notice, Agenda and Minutes of a meeting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.3 Business meeting etiquettes</td>
<td></td>
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<tr>
<td>05</td>
<td>Introduction to Corporate Ethics</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>5.1 Professional and work ethics (responsible use of social media - Facebook, WA, Twitter etc.)</td>
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<tr>
<td></td>
<td>5.2 Introduction to Intellectual Property Rights</td>
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<tr>
<td></td>
<td>5.3 Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response and making ethical decisions)</td>
<td></td>
</tr>
</tbody>
</table>
Employment Skills
6.1 Group Discussion
6.2 Resume Writing
6.3 Interview Skills
6.4 Presentation Skills
6.5 Statement of Purpose

Assessment:

List of Assignments
1. Report Writing (Theory)
2. Technical Proposal
4. Interpersonal Skills (Group activities and Role plays)
5. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
6. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
7. Corporate ethics (Case studies, Role plays)
8. Writing Resume and Statement of Purpose

Term Work
Term work shall consist of all assignments from the list.

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

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

References:
1. Fred Luthans, “Organizational Behavior”, Mc Graw Hill,
3. R.Subramaniam, “Professional Ethics” Oxford University Press
5. Raman and Sharma, Fundamentals of Technical Communication, Oxford University Press
9. Raman Sharma, Communication Skills, Oxford University Press
13. Dr. K. Alex ,”Soft Skills”, S Chand and Company
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEC601</td>
<td>Machining Science and Technology</td>
<td>04</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life and surface roughness.
2. To familiarize with various single and multipoint cutting tools designing processes.
3. To prepare for understanding the economics of machining process.

**Outcomes:** Learner will be able to…
1. Calculate the values of various forces involved in the machining operations.
2. Analyse the effect of temperature and cutting fluids in metal cutting.
3. Analyse the surface integrity after post machining.
4. Design various single/multipoint cutting tools.
5. Select an appropriate tool material for particular machining application.
6. Demonstrate the interrelationship between cutting parameters and machining performance measures.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Metal Cutting Theory:</strong> Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant’s force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant’s model &amp; modified model for orthogonal cutting, Lee and Shaffer model. Analytical modelling of machining operations, mechanistic modelling of machining, slip line field analysis, finite element analysis, modelling of material properties. <strong>Dynamometry:</strong> Dynamometer requirements, force measurement, electric transducers, strain gage lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, surface grinding dynamometer, piezoelectric dynamometry.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Temperatures in metal cutting and cutting fluids:</strong> Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, temperature in primary deformation zone, temperature in secondary deformation zone, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work-tool thermocouple, direct thermocouple measurement, radiation methods, hardness and microstructure changes in steel tools. Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, cutting fluid maintenance and environmental considerations, disposal of cutting fluids, dry cutting and minimum quantity lubrication, cryogenic cooling.</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td><strong>Cutting tool materials and machining induced Surface Integrity</strong> Properties of cutting tool materials. Major tool material types. Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools. 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, residual stress and microhardness.</td>
<td></td>
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</tr>
<tr>
<td>04</td>
<td><strong>Tool life and machining economics:</strong> 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.</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td><strong>Design of single point cutting tools:</strong> 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.</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td><strong>Design of Multi point cutting tools:</strong> 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. Design of face and peripheral milling cutters.</td>
<td></td>
</tr>
</tbody>
</table>

**Assessment:**

**Internal Assessment for 20 marks:**
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

**Reference Books:**
### Course Code
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEC602</td>
<td>Process Engineering and Tooling</td>
<td>04</td>
</tr>
</tbody>
</table>

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

#### Outcomes: Learner will be able to…
1. Determine machine sequences to cater to the manufacturing requirements.
2. Analyse part prints.
3. Prepare tolerance control charts with its balancing.
4. Design work holding devices for consistent positioning of work piece in relation to the tool.
5. Prepare process picture, process routing/process sheets.
6. Design cams for part production on single spindle automats.

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<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Process Engineering</strong>&lt;br&gt;Differentiation between Product Engg and Process Engg. Role of process engineering in a manufacturing setup, organization chart, functions of process engineering. Determining machining sequences - criteria and manufacturing sequence.</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td><strong>2.1 Preliminary Part Print Analysis</strong>&lt;br&gt;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, case study for understanding preliminary part print analysis.</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td><strong>2.2 Work piece control</strong>&lt;br&gt;Causes of work-piece variations, variables influencing work-piece control, work piece control techniques - Equilibrium theories, concept of location, geometric control, dimensional control, mechanical control, alternate location theory.</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td><strong>Tolerance Design</strong>&lt;br&gt;<strong>Dimensional Analysis:</strong> Types of dimensions, concept of baseline dimension, basic geometric dimensioning and tolerance (GD &amp; T).&lt;br&gt;<strong>Tolerance Analysis:</strong> 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.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Process planning</strong>&lt;br&gt;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.&lt;br&gt;<strong>4.2 Computer Aided Process Planning (CAPP):</strong> CAPP -variant approach and generative approach.(Detail)</td>
<td>06</td>
</tr>
</tbody>
</table>
| 05 | **5.1 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. | 12 |

| 06 | **5.2 Other aspects of Process Engineering**  
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).  
**Cam Design for Automat**  
Automats major classification& types, tools and tool holders, magazines, and hoppers for feeding.  
Single spindle automats and its tooling, tool layout and cam design for part production on Single spindle automat. | 10 |

**Assessment:**

**Internal Assessment for 20 marks:**
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**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
4. **Only Four questions need to be solved**

**Reference Books:**
2. Production Technology, HMT.
3. Manufacturing Engineering,V. Danilevsky, Mir publication.
6. HSS and Carbide Tool Catalogues for Turning, Drilling, Milling, Boring etc. from Tool manufactures.
8. PMT Catalogue Traub Automat
**Course Code** | **Course Name** | **Credits**
---|---|---
PEC603 | Production Tooling | 04

**Objectives:**
1. To acquaint with the concepts pertaining to planning and sequencing of operations.
2. To familiarize with the capabilities of designing a simple productive and cost effective jigs and fixtures.
3. To acquaint with the various press working operations for mass production of sheet metal components.
4. To familiarize with the sheet metal working techniques for design of press tools.

**Outcomes:** Learner will be able to…
1. Select location and clamping faces/points on jobs.
2. Design and develop simple productive and cost effective jigs.
3. Design and develop simple productive and cost effective fixtures.
4. Identify press tool requirements to build concepts pertaining to design of press tools.
5. Prepare working drawings and setup for economic production of sheet metal components.
6. Demonstrate the principles of blank development in bent & drawn components.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
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</thead>
</table>
| 01 | **Introduction to Jigs and Fixture:**
1.1 Introduction to Jigs and Fixtures, their difference and Significance. Material used for different elements of jigs/fixtures and recommended hardness where necessary.
1.2 Location & Locating Devices: Locating principles, Degrees of freedom, Redundant location, Fool proofing, nesting, Locators: location from Flat and cylindrical surfaces, conical locators, centralizers.
1.3 Clamping & Clamping Devices: Clamping Principle, Examples of typical clamps such as multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic & hydraulic devices. | 08 |
| 02 | **Construction of Drill Jig**
2.1 Introduction, Selection of location, supporting and clamping faces/points.
2.2 Various types of Jig Bushes.
2.3 Commonly used Drill jigs. Case Study on Drill Jig Design. | 08 |
| 03 | **Construction of Milling fixture**
3.1 Introduction, Selection of location, supporting and clamping faces/points.
3.2 Tool setting & cutter guiding (Tennons & Setting block).
3.3 Case Study on Milling Fixture Design. | 08 |
<table>
<thead>
<tr>
<th>04</th>
<th>Introduction to Press Working</th>
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</thead>
<tbody>
<tr>
<td>4.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components.</td>
<td></td>
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<tr>
<td>06</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>05</th>
<th>Design and Calculations for Piercing &amp; Blanking Die</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Different types of Dies, Die sets and its selection.</td>
<td></td>
</tr>
<tr>
<td>5.3 Design aspects of Press tool elements viz. Punches &amp; methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools.</td>
<td></td>
</tr>
<tr>
<td>5.4 Selection of materials and its hardness for different elements of Press tools.</td>
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<tr>
<td>10</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>06</th>
<th>Bending &amp; Drawing Dies</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2 Theory of Drawing. Metal flow in Drawing &amp; forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup.</td>
<td></td>
</tr>
<tr>
<td>6.3 Defects in drawn as well as bent parts. Presses selection for drawing/bending operations.</td>
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</tr>
<tr>
<td>6.4 Basic construction and working of Bending and Drawing dies.</td>
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</tr>
<tr>
<td>08</td>
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</tbody>
</table>

**Assessment:**

**Internal Assessment for 20 marks:**

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

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2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved
Reference Books:

1. *Production Engineering* – P. C. Sharma
3. *Jigs and Fixture*, P.H. Joshi, THM.
8. *Tool Design* – C. Donaldson
Course Code | Course Name | Credits
---|---|---
PEC604 | Machine Design - II | 04

**Objectives:**
1. To familiarize with the constructional & design features of machine tool structures like bed, columns, slide ways/guideways and mechanical drives.
2. To prepare for a skills in designing feed gear boxes, bearings, power screws, clutches etc. used in machine tools.
3. To acquaint with the usage of standards & hand books and retrieve relevant data from these for designing/selection of machine tool components.
4. To appraise about safety and safety standards pertaining to machine tools.
5. To acquaint with the recommended procedure of carrying out acceptance tests on machine tools & their significance.

**Outcomes:** Learner will be able to…
1. Design machine tool structures, drive elements/drives.
2. Design feed gear boxes.
3. Design power screws and clutches.
4. Design bearings.
5. Demonstrate the requirements like maintaining of expected accuracy levels, parametric optimization, managing wear and tear problems.
6. Illustrate the safety aspects/ acceptance tests in machining tools.

<table>
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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>ELEMENTS OF MACHINE TOOLS</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>1.1 Types and capabilities of various machine tools. General purpose, and special purpose machine tools.</td>
<td></td>
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<tr>
<td></td>
<td>1.2. Design of machine tool structures :-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2.1 Design of bed &amp; columns - Materials of construction, Profiles, Static and dynamic stiffness. Designing for strength and rigidity. Methods of enhancing rigidity. Design of machine tool bed cross-section like lathe bed. Design of simple machine tool columns like pillar drill column etc. on the basis of strength and rigidity.</td>
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<tr>
<td></td>
<td>1.3 Design of mechanical drives:</td>
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<tr>
<td></td>
<td>1.3.1 Design of belt drives - Design of belts, belt materials, belt types:- specification and selection, types of pulleys and design of pulleys.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>DESIGN OF SPEED AND FEED BOXES</td>
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<td>----</td>
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<td></td>
</tr>
</tbody>
</table>
| 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, 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, Meander 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. |
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<table>
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<tr>
<th>03</th>
<th>DESIGN OF POWER SCREWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 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 on ball recirculating power screws.</td>
<td></td>
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<tr>
<td>04</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>04</th>
<th>DESIGN OF CLUTCHES</th>
</tr>
</thead>
</table>
| 4.1 Design considerations, materials of clutch plates & linings. Running conditions- wet & dry. 
4.2 Design of plate clutches. Single and multiplate clutches involving design of clutch plates, springs & operating lever. |
| 04 |

<table>
<thead>
<tr>
<th>05</th>
<th>DESIGN OF MACHINE TOOL BEARINGS</th>
</tr>
</thead>
</table>
5.2 Design of journal bearings – Terminology. Theory of lubrication, bearing characteristic Number, Sommerfeld Number, calculations involving bearing dimensions, clearance, coefficient of friction, heat generated, heat dissipated and power lost in friction. Mounting & maintenance of bearings. |
| 07 |

<table>
<thead>
<tr>
<th>06</th>
<th>SAFETY OF MACHINE TOOLS &amp; ACCEPTANCE TESTS</th>
</tr>
</thead>
</table>
| 6.1 Safety concepts, various safety devices incorporated in machine tools to safeguard safety of man, tools and equipment. Interlocked, fool proof safety systems. Introduction to safety standards. 
6.2 Acceptance tests on machine tools: Significance, performance and geometrical tests on lathe, milling, drilling and shaping machines. 
6.3 Vibrations in machine tools:- Elementary concepts about factors contributing to vibrations, vibration detection and measurement, remedial approaches |
| 05 |

**NOTE:**
Use of standard design data books like PSG data book is permitted at the examination and shall be supplied by the college.
Assessment:

Internal Assessment for 20 marks:
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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
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4. Only Four questions need to be solved

Reference Books:
2. Machine tool design and Numerical Control, N.K.Mehta, Tata MGH
5. The design and construction of machine tools, H.C.Town.
   Tata MGH
Objectives:
1. To prepare for understanding of the role of production and operations management in the overall business strategy of the firm.
2. To prepare for understanding of the interdependence of the operating system with other key functional areas of the firm.
3. To familiarize with the key factors and interdependence of these factors in the design of effective operating systems.
4. To prepare for identification and evaluation of tools appropriate for analysis of operating systems of the firm.
5. To familiarize with the application of production and operations management policies and techniques to the service sector as well as manufacturing firms.

Outcomes: Learner will be able to...
1. Analyze implications of Production and Operations Management in industries.
2. Demonstrate the role of Production Management in creating competitive advantage for business organizations.
3. Analyze various constituents of production operations in manufacturing and service.
4. Plan and control various production related activities.
5. Illustrate various inventory management procedures with the tools employed there in.
6. Demonstrate role of JIT, MRP, and ERP with their contribution towards production and operations management.
### Assessment:

**Internal Assessment for 20 marks:**

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4. Only **Four questions need to be solved**

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<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2</td>
<td><strong>Facility Layout / Plant Layout</strong>&lt;br&gt;(numerical on this topic)&lt;br&gt;Types of Layout, Significance and Factors influencing layout choices, Principles of Plant layout, Computerised Layout Techniques.</td>
</tr>
<tr>
<td>3.3</td>
<td><strong>Materials Handling</strong>&lt;br&gt;Function, Importance and Objectives of Material Handling, Material handling Principles, Types of Material Handling Systems, Selection of Material Handling Equipments, Evaluation of Material handling Performance Relationship with Plant layout (numerical on this topic).</td>
</tr>
<tr>
<td>04</td>
<td><strong>Production Planning and Control</strong>&lt;br&gt;Classification of PPC functions, Factors determining PPC, procedure Role of PPC in POM, Principles of PPC, PPC in different Production System, Organisation of PPC department.</td>
</tr>
<tr>
<td>05</td>
<td><strong>Inventory Management</strong>&lt;br&gt;Nature, Importance, Classification and Functions of Inventory, Inventory Costs, Importance of Inventory Management, Inventory Control System for Dependent Demand and Independent Demand, Inventory Ordering Systems. Inventory Control subject to Known Demand. The EOQ Model, Extension to Finite Production Rate, Quantity Discount Model (numerical on this topic).Inventory Control subject to Uncertain Demand, The Newsboy Model, Service Levels in Q and R Systems, (numerical on this topic)</td>
</tr>
<tr>
<td>06</td>
<td><strong>Advance Topics in POM</strong>&lt;br&gt;Material Requirement Planning (MRP) (numerical on this topic), Manufacturing Resource Planning (MRP II), Enterprise Resource Planning (ERP), Just in Time Manufacturing, Lean Production, Agile Manufacturing, Line Balancing (numerical on this topic), Line of Balance (numerical on this topic), Sustainable Production and Green Manufacturing.</td>
</tr>
</tbody>
</table>
Reference Books:

1. Production and Operations Analysis by Steven Nahmias, McGraw-Hill/Irwin publication
3. Elements Of Production Planning And Control by Eilon, Samuel, New York: Macmillan
4. Production Planning and Control by Prof. Jhamb L.C. by Everest Publishing House
8. Production and Operations Management by R. Panneerselvam, Prentice-Hall Of India
10. Orlicky's Material Requirements Planning, by Carol Ptak, MGH
11. Enterprise resource planning: concepts and practice by Vinodkumar Garg PHI Learning
13. Toyota Production System: An Integrated Approach to Just-In-Time, by Yasuhiro Monden, CRC PRESS
Objectives
1. To provide a profound insights into how to coordinate the supply, production and distribution functions.
2. To provide an insight in knowhow to balance a conflicting objectives to minimize the total costs involved and maximize customer service.
3. To prepare for analytical abilities to formulate, solve and analyze problems arising in modern production and inventory systems.

Outcomes: Learner will be able to…
1. Analyze all aspects of a successful manufacturing planning and control infrastructure.
2. Design demand management scheme.
3. Illustrate the significance of sales and operations planning.
4. Design and oversee an effective master production schedule.
5. Design materials requirements planning.
6. Analyze capacity planning and management.

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<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</td>
<td>MPC concept and Significance</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Typical MPC support activities. An MPC system framework matching, MPC system with the needs of the firm, Evaluation of the MPC system.</td>
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<tr>
<td>02</td>
<td>2.1 Demand Management in MPC system</td>
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</tr>
<tr>
<td></td>
<td>Demand management and the MPC environment, Sales and Operations planning, Information Use in Demand management.</td>
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<tr>
<td></td>
<td>2.2 Forecasting</td>
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<tr>
<td></td>
<td>The time Horizon in Forecasting, characteristics of Forecast, Subjective Forecasting Methods, Objective Forecasting Methods, Methods for Forecasting Stationery Series, Trend Based Mthods, Method for Seasonal Series, Evaluating Forecasts, Practical Considerations</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>3.1 Aggregate Planning</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Overview of the Aggregate Planning Problem, Costs in Aggregate Planning, Evaluation of various strategy, Modelling Management behaviour, Disaggregating Aggregate Plans, Practical Considerations</td>
<td></td>
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<tr>
<td></td>
<td>3.2 Master Production Scheduling</td>
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<tr>
<td></td>
<td>The MPS activity, The MPS techniques, Bill of Materials Structuring for the MPS, The final assembly schedule, MPS stability.</td>
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<tr>
<td>04</td>
<td>4.1 Capacity Planning and Utilisation</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>4.2 Production Activity and Control (PAC)</td>
<td></td>
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<tr>
<td></td>
<td>A framework for PAC, PAC Techniques.</td>
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</tr>
</tbody>
</table>
| 05 | **Strategy and MPC System Design**  
MPC Design options, Choosing the Options, Integrating MRP and JIT, Extending MPC integration to customers. |
| 06 | Advanced concepts in MRP, ERP, JIT and Scheduling, MPC implementation. |

**Assessment:**

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4. Only Four questions need to be solved

**Reference Books:**
1. Manufacturing planning and control systems by Thomas E. Vollmann, MGH.
2. Master production scheduling: principles and practice, William L. Berry, MGH.
9. Production Planning and Inventory Control, Seetharama L. Narasimhan, Prentice Hall.
### Objectives:
1. To familiarize with the working and operating principles of Vapour Compression and Vapour Absorption systems.
2. To familiarize with the components of refrigeration and air conditioning systems.
3. To familiarize with the design air conditioning systems using cooling load calculations.

### Outcomes:
Learner will able to…
1. Demonstrate fundamental principles of refrigeration and air conditioning.
2. Locate various important components of the refrigeration and air conditioning system.
3. Illustrate the properties of refrigerants.
4. Use psychrometric chart.
5. Design and analyse complete air conditioning systems.
6. Design ducts for conditioning system.

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<thead>
<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Refrigeration:</strong> Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Coefficient of Performance, Energy Efficiency Ratio (EER), BEE star rating</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td><strong>Vapour Compression Refrigeration System:</strong> Simple vapour compression cycle, Effect of liquid sub cooling &amp; superheating, effect of evaporator and condenser pressures, methods of sub cooling, use of P-h charts, Actual VCR cycle. Types of condensers, evaporators, expansion devices and Compressors. Use of enhanced surface tubes in Heat Exchangers. Cooling tower: Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance. <strong>Refrigerants</strong>- Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties. Secondary refrigerants, ODP and GWP, Montreal protocol and India’s commitment, Recent substitutes for refrigerants.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Vapour Absorption Refrigeration:</strong> Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system. Solar VAR system. <strong>Nonconventional Refrigeration Systems</strong> : Thermoelectric Refrigeration, Thermoacoustic Refrigeration, Vortex Tube Refrigeration</td>
<td>06</td>
</tr>
</tbody>
</table>
### Psychrometry
Need for air conditioning, Principle of psychrometry, Psychometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.

### Design of air conditioning systems

### Duct Design and Applications
Friction chart for circular ducts. Equivalent diameter of a circular duct for rectangular ducts, Static pressure regain and equal pressure drop methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling & heating. Controls – LP/HP cutoff, Thermostats, Humidistats, Interlocking control, Electronic Controllers, Applications Refrigeration & A/C Ice plant – food storage plants – dairy and food processing plants, Food preservation, Freeze Drying, A/c in textile, printing pharmaceutical industry and Hospitals

### Assessment:

#### Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

#### End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

### Reference Books:
1. *Refrigeration and air-conditioning* – C P Arora, TMH
5. *Refrigeration and air-conditioning*– Manohar Prasad, New Age Int (P) Ltd.
6. *Basic Refrigeration and air-conditioning* - P. Ananthnarayana, TMH
7. *Refrigeration and air-conditioning*– V. M. Domkundwar
Objective:
1. To introduce the basic concepts of Reliability Engineering for ensuring sustainable product management.
2. To familiarize with the application of engineering knowledge and statistical techniques to prevent or to reduce the likelihood of frequency of failure.
3. To familiarize with the reliability of new designs and its analysis based on data.
4. To familiarize the concept of reliability testing and simple calculations.

Outcomes: Learner will be able to…
1. Analyze different modes of failure with its interpretations.
2. Demonstrate an integrated approach for achieving optimum product reliability.
3. Select appropriate reliability testing method/report failure.
4. Demonstrate the concept of reliability predication and analysis techniques.
5. Illustrate the concept of maintainability and availability related to reliability.
6. Illustrate the different corporate strategies for product reliability management.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Reliability and Failure Concept: Definition, Role of reliability functions in the organization, Quality and reliability, Significance and importance of reliability. Concept of Failure, Causes of failures, Failure and hazard rate, Reliability expressions for constant, increasing and decreasing hazard rates, Component Reliability, Mean Time To Failure (MTTF), Mean Time Between Failure (MTBF), Time dependent and Stress dependent hazard models, Numerical based on calculations of failure rate and hazard rate.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td>System Reliability: Basic Probability concept, Introduction to independence, mutually exclusive, conditional probability, Discrete and continuous probability distributions, Data analysis based on Probability distributions (Exponential, Wei-bull, Normal, Gamma, Poisson, Lognormal and extreme value), Conditional Probability. Analysis of Series, parallel, series-parallel, standby and k-out of m modelling. System reliability evaluation technique including methods of bounds, decomposition and transformation techniques. Single and Multiple variable inversion techniques for minimizing system reliability expression. Tie-set and cut- set method.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Reliability Design: Functional Designs, Designing for reliability, Design process, Optimal reliability and redundancy techniques, Failure and repair rate allocation, Various design problems and their relevant solution techniques, Reliability improvements.</td>
<td>04</td>
</tr>
<tr>
<td>04</td>
<td>Reliability Predication and Analysis: Reliability predication methodology, System reliability analysis techniques – Failure Mode Effects Analysis (FMEA), Failure Mode effects and critically analysis (FMECA)-Case studies, Basic symbols, Fault tree construction and</td>
<td>10</td>
</tr>
</tbody>
</table>
analysis, Failure Mechanism- Types, Introduction to computer aided reliability.

Maintainability and Availability:
Availability: Function and Analysis.
Trade-off between reliability, Maintainability and Availability, Planning for safety.

Reliability Testing and Management
Introduction to Reliability Testing, Stress strength interaction, Testing for reliability and Durability-Accelerated Life Testing and Highly Accelerated Life Testing (HALT), Highly accelerated stress screening (HASS).
Objective of reliability management, Typical reliability control organization, Integrated reliability programs, Costs and productivity, Reliability audit, Customer involvement, Reliability considerations in production, Reliability specifications and contracts, Reliability data system and data bank.

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:
12. “Recent Advances in Reliability and Quality”, Hoang Pham, World Scientific Technology.
### Course Code | Course/Subject Name | Credits
---|---|---
PEDLO6014 | Industrial Robotics | 03

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

### Outcomes: Learner will be able to…
1. Illustrate the importance of robot in automation.
2. Acquire skills in robot language and programming.
3. Acquire skill in robot task planning for problem solving.
4. Demonstrate the concepts of kinetics and dynamics of robot.
5. Select various sensors/robot peripherals for deployment in a manufacturing system.
6. Identify an application of robots in manufacturing.

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<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction</strong>&lt;br&gt;Automation, robotics, Robotic system &amp; Anatomy, Classification and Future Prospects.</td>
<td>02</td>
</tr>
<tr>
<td>02</td>
<td><strong>2.1 Drives</strong>&lt;br&gt;Control Loops, Basic Control System Concepts &amp; Models, Control System Analysis, Robot Activation &amp; Feedback Components, Position &amp; Velocity Sensors, Actuators and Power Transmission system.&lt;br&gt;<strong>2.2 Robot &amp; its Peripherals</strong>&lt;br&gt;<strong>2.3 End Effecters</strong>: Type mechanical and other grippers, Tool as endeffecter.&lt;br&gt;<strong>Sensors</strong>: Sensors in Robotics, Tactile Sensors, Proximity &amp; Range Sensors, Sensor Based Systems, Vision systems and Equipment. Introduction to the Microcontroller (Arduino) and interfacing with a sensor</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>3.1 Machine vision</strong>&lt;br&gt;Introduction, Low level &amp; High level Vision, Sensing &amp; Digitizing, Image Processing &amp; analysis, Segmentation, Edge detection, Object Description &amp; recognition, interpretation and Applications.&lt;br&gt;<strong>3.2 Programming for Robots</strong>&lt;br&gt;Method, Robot Programme as a path in space, Motion interpolation, motion &amp; task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>4.1 Robot Kinematics</strong>&lt;br&gt;Forward, reverse &amp; Homogeneous Transformations, Manipulator Path control and Robot Dynamics.</td>
<td>08</td>
</tr>
</tbody>
</table>
5.1 Root Intelligence & Task Planning

6.1 Robot application in manufacturing
Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, Social issues & Economics of Robotics.

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:
3. Robotic technology & Flexible Automation, S R Deb. TMH.
6. Robot Analysis & Control, H Asada, JJE Slotine.
7. Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.
Objectives:
1. To acquaint with various rapid prototyping and additive manufacturing technologies.
2. To familiarize with the concept of Direct Digital Manufacturing.
3. To familiarize with the various Rapid tooling and Reverse engineering techniques.
4. To introduce the concept of Digital Manufacturing.

Outcomes: Learner will be able to...
1. Demonstrate an importance of rapid prototyping/additive manufacturing techniques.
2. Design and develop of products using rapid manufacturing technology.
3. Design and develop of products using additive manufacturing technology.
4. Illustrate the concept of Direct Digital Manufacturing.
5. Select appropriate Reverse engineering techniques for a particular case.
6. Select appropriate Rapid tooling techniques for a particular case.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Rapid Prototyping (RP) and Additive Manufacturing (AM)</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Additive Manufacturing / Rapid Prototyping Systems</td>
<td>10</td>
</tr>
</tbody>
</table>
| 03 | **Direct Digital Manufacturing**  
Concept of Direct Digital Manufacturing (DDM), Application Case Studies, DDM Drivers |
| 04 | **Design for Additive Manufacturing**  
4.1 AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity, Material Complexity.  
4.2 Core DFAM Concepts and Objectives: Complex Geometry, Integrated Assemblies, Customized Geometry, Multifunctional Designs, Elimination of Conventional DFM Constraints |
| 05 | **Rapid Tooling and Reverse Engineering**  
5.1 Introduction to Rapid Tooling, Indirect Rapid Tooling Processes, Direct Rapid Tooling Processes, Emerging Trends in Rapid Tooling  
5.2 Reverse Engineering (RE): Introduction, RE generic process, RE hardware and software, Integration of RE and RP for Layer-based Model Generation, Applications and case studies of RE in automotive, aerospace and medical device industry, Barriers for adopting RE. |
| 06 | **Digital Manufacturing**  
Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

Objectives
1. To familiarize with the methods of force measurement during machining.
2. To familiarize with the methods of temperature measurement during machining.
3. To familiarize with the Taguchi’s Design of Experiments and ANOVA.
4. To familiarize with the design procedures for various cutting tools.

Outcomes:- The learner will be able to…
1. Select a proper force measurement method for the required machining operation.
2. Select a proper temperature measurement method for the required machining operation.
3. Distinguish surface integrity after parametrical changes in machining operation.
4. Apply Taguchi’s Design of Experiments and ANOVA for various machining operations.
5. Design multi point cutting tool like Broach.
6. Design of Flat Form Tool and Circular Form Tool.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Design Exercise/Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Assignment on Dynamometry and Metal Cutting Theory</td>
</tr>
<tr>
<td>02</td>
<td>Assignment on Temperature Measurement in metal cutting and cutting fluids</td>
</tr>
<tr>
<td>03</td>
<td>Assignment Introduction to Taguchi Design of Experiments and ANOVA – Two Case Studies on applications in machining.</td>
</tr>
<tr>
<td>04</td>
<td>Design of Circular Broach.</td>
</tr>
<tr>
<td>05</td>
<td>Design of Flat Form Tool.</td>
</tr>
<tr>
<td>06</td>
<td>Design of Circular Form Tool.</td>
</tr>
</tbody>
</table>

Term Work
Term work shall consist of exercises listed in the above list
The distribution of marks for term work shall be as follows:
Assignments : 10 marks
Design Exercises with Drawings on A4 size Paper : 10 marks
Attendance : 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
Objectives.
1. To familiarize with the significance of process engineering and its relevance to manufacturing operations.
2. To prepare for developing skills in preparing machining sequence and estimating manufacturing time.
3. To acquaint with the significance and control of tolerance in design & manufacturing.
4. To appraise a basics of process and operation planning.

Outcomes: Learner will be able to…
1. Develop capability to prepare part prints.
2. Develop workpiece control system.
3. Develop tolerance control charts and process sheets.
4. Develop tool layout for production lathe.
5. Develop process picture, process routing, process sheets.
6. Design cams for part production on single spindle automats.

<table>
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<tbody>
<tr>
<td>01</td>
<td>Assignment on introduction to process engineering.</td>
</tr>
<tr>
<td>02</td>
<td>Assignment on Part print analysis.</td>
</tr>
<tr>
<td>03</td>
<td>Assignment on Work piece control.</td>
</tr>
<tr>
<td>04</td>
<td>Prepare Tolerance Chart Design for one component.</td>
</tr>
<tr>
<td>05</td>
<td>Design of Tool Layout for production lathe.</td>
</tr>
<tr>
<td>06</td>
<td>Design process planning sheet with process picture.</td>
</tr>
<tr>
<td>07</td>
<td>Design of Cams for Traub Automat.</td>
</tr>
</tbody>
</table>

Term Work
Term work shall consist of assignments based on the syllabus and exercises as mentioned in the table above as well as a detailed report, based on an Industrial visit to a manufacturing firm, covering few of the essential concepts mentioned in subject of Process Engineering and Tooling. The report should cover the importance of optimisation of various resources like Time, Material etc. in today’s manufacturing firms.

The distribution of marks for term work shall be as follows:
Design Exercise : 12 marks
Assignments : 05 marks
Industrial Visit Report : 03 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.
**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. Student’s work along with evaluation report to be preserved till the next examination.
Course Code | Course Name | Credits
---|---|---
PEL603 | Production Tooling Laboratory | 01

**Objectives:**
1. To acquaint with the concepts pertaining to planning and sequencing of operations.
2. To prepare for designing of simple productive and cost effective jigs and fixtures
3. To acquaint with the various press working operations for mass production of sheet metal components.
4. To familiarize with the sheet metal working techniques for design of press tools.

**Outcomes:** The students will be able to…
1. Identify and select location and clamping faces/points on jobs.
2. Design and develop simple productive and cost effective jigs.
3. Design and develop simple productive and cost effective fixtures.
4. Identify press tool requirements to build concepts pertaining to design of press tools.
5. Prepare working drawings and setup for economic production of sheet metal components.

**Term Work**
Term work shall consist of:

A : Design of
1. Simple Progressive Die with minimum three stages.
   (Assembly & BOM)
2. Drill Jig (Assembly & BOM).

B : A detailed report based on an Industrial visit to a manufacturing firm, covering the topics mentioned in subject of Production Tooling.

Assignments on topics drawn from the syllabus are as follows:
- One assignment/module on module nos. 1, 2, 3 and 1 physical model/prototype (by a group of 4 students) on module 4, 5 or 6. OR
- One assignment/module on module nos. 4, 5, 6 and 1 physical model/prototype (by a group of 4 students) on module 1, 2 or 3.

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

- Part A: Design task : **12 marks**
- Part B: Assignments : **05 marks**
- Industrial Visit Report : **03 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.
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 |
| Oral        | … | 10 |

1. Evaluation of practical/oral examination to be done based on the performance of design task.
2. Student’s work along with evaluation report to be preserved till the next examination.
Course Code | Course Name | Credits
---|---|---
PEL604 | Machine Design – II Laboratory | 01

**Objectives:**
1. To familiarize with the concept of design features of machine tool structures.
2. To acquaint with design principles of feed gear boxes, bearings, power screws, clutches etc. used in machine tools.
3. To acquaint with the standards & hand books to retrieve relevant data for designing/selection of machine tool components.
4. To acquaint with the acceptance tests on machine tools & 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.
3. Select drive elements and drives for machine tools.
4. Design feed gear boxes for a machine tool.
5. Design bearings and clutches for a machine tool.
6. Design power screws for a machine tool.

<table>
<thead>
<tr>
<th>Sr.no</th>
<th>Design Exercise/ Assignment</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Design of mechanical drives (At least one design and drawing)</td>
</tr>
<tr>
<td>02</td>
<td>Design and drawing of machine tool guideways, slideway profiles, wear compensation techniques.</td>
</tr>
<tr>
<td>03</td>
<td>Design and drawing of machine tool structure profiles.</td>
</tr>
<tr>
<td>04</td>
<td>Demonstration of acceptance test on at least one machine tool.</td>
</tr>
<tr>
<td>04</td>
<td>Assignment on power screws.</td>
</tr>
<tr>
<td>05</td>
<td>Assignment on clutches.</td>
</tr>
<tr>
<td>06</td>
<td>Assignment each on antifriction bearing &amp; journal bearing.</td>
</tr>
</tbody>
</table>

**Term Work:**
Term work shall consist of design exercises and assignments as per the list given above
The distribution of marks for term work shall be as follows:
- Laboratory work (Experiments/ design and drawings): 15 marks
- Assignments: 05 marks
- Interest & involvement: 05 marks
- TOTAL: 25 Marks.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>PEC701</td>
<td>Industrial Training and Project</td>
<td>20</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To correlate with the lessons learnt in theory and actual practices followed in the industries.
2. To give exposure to an industrial environment/discipline.
3. To familiarize with the need for a coordinated effort of various persons at different levels in different departments for achieving the set goals and targets.

**Outcomes:** Learner will be able to…
1. Demonstrate managerial skills.
2. Identify the size and scale of operations in Industry.
3. Apply the knowledge in problem solving.
4. Demonstrate an understanding of various constraints in industry.
5. Demonstrate the scope, functions and job responsibilities in various departments of an organization.
6. Develop a positive attitude while dealing in professional manner.

**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. Contents of the presentation.
2. Presentation skills.
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. 10
2. Company background/ activities. 10
3. Training areas / Training details. 15
4. Synopsis / Abstract of the Project. 25
5. General presentation, neatness and accuracy of the data furnished. 30
6. Technical contents of the report with data / observations, graphs, drawings, etc. Observations/involvement. 10
7. Quality of work carried out and details furnished based on personal Observations/involvement. 10
8. Results/ Conclusion. 10

**Total - 100**

**Note:** Report shall be prepared using University of Mumbai approved Guidelines, as applicable.
Course Code | Course Name | Credits
--- | --- | ---
PPEC801 | Fluid Power Automation | 04

**Objectives:**
1. To familiarize with the basic concepts of industrial automation.
2. To acquaint with the concept of low cost automation with pneumatic and hydraulic systems.
3. To familiarize with the elements of electrical control systems.
4. To acquaint with the concepts related to fluid power.

**Outcomes:** Learner will be able to…
1. Apply automation techniques in small manufacturing set-ups.
2. Illustrate the working principles of fluid power accessories like pumps, motors.
3. Analyse pneumatic and hydraulic circuits of medium complexity.
4. Illustrate the working of control and regulation elements used in pneumatic and hydraulic circuits.
5. Demonstrate the use of electrical and electronics control in pneumatic and hydraulic circuits.
6. Analyse the benefits and challenges of Digital Hydraulics.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 01 | **Introduction to Fluid Power Automation:**
Definition; Automation in production systems; Automation principles and strategies; Levels of automation; Types of automation; Benefits and Impact of Automation on Manufacturing and Process Industries.
Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria. | 08 |
| 02 | **Fluid Power Generating/Utilizing Elements**
| 03 | **Control And Regulation Elements**
Hydraulic and pneumatic direction, flow and pressure control valves. Methods of actuation, types, sizing of ports – pressure and temperature compensation, overlapped and under lapped spool valves – operating characteristics-electro hydraulic and electro-pneumatic servo valves-different types-characteristics and performance. Difference between Servo and Proportional hydraulic valve. | 06 |
| 04 | **Circuit Design**
**Basic Hydraulic Circuits:** Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits.
**Pneumatic Circuit Designing:** Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 3 cylinders). | 12 |
Sensors and Transducers:
Performance Terminology; 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.

Electro Pneumatics & Electronic Control Of Hydraulic and Pneumatic Circuits:
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) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.

Digital Hydraulics: Definition & Introduction, Digital vs. analog hydraulic control, different ways to realize motion control with on/off valves, Benefits and challenges of digital Hydraulics, Application case studies.

Assessment:

Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:
3. Peter Croser, Frank Ebel, Pneumatics Basic Level, Festo Didactic GmbH & Co. Germany.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEC802</td>
<td>Industrial Engineering and Human Resource Management</td>
<td>04</td>
</tr>
</tbody>
</table>

**Objectives**

1. To familiarize with the practices of industrial engineering and human resource management.
2. To familiarize with the concepts of strategic objectives, optimization of human resource potential and enhancing of human effectiveness.

**Outcomes** learner will be able to…

1. Apply different industrial engineering principles for productivity enhancement.
2. Design integrated systems in industrial engineering.
3. Develop a concept in identifying, planning, and deployment of man power.
4. Develop an inter personal and soft skills.
5. Identify the training needs of employs at different levels.
6. Analyze legal aspects of employment

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>1.1 Introduction to Industrial Engineering (IE):</strong> Definition, History and Development of IE, Present Scenario of IE, Contributions to IE, Activities and approaches of IE, Objectives and Functions of IE. <strong>Productivity:</strong> Definition, Productivity in Enterprise, Task of Management, Productivity of Materials, Land, Building, Machine and Power. Measurement of Productivity, Factors affecting productivity, Productivity Improvement likes 5s, Poka-Yoke, Kaizen, Kanban, Quality Improvement Techniques like QFD, FMEA, Ishikawa diagram, SMED <strong>1.2 Method Study:</strong> Objectives and procedure for methods analysis, Recording techniques, Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design. <strong>1.3 Work Measurement:</strong> Objectives, Work measurement techniques - time study, work sampling, predetermined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time, Maynard’s Operation Sequence Technique (MOST). <strong>1.4 Job Evaluation and Wage Plan:</strong> Objective, Methods of job evaluation, job evaluation procedure, merit rating (performance appraisal), method of merit rating, wage and wage incentive plans.</td>
<td>14</td>
</tr>
<tr>
<td>02</td>
<td><strong>2.1 Value Analysis :</strong> An Overview Of Value Analysis - Concepts and approaches of value analysis and engineering - importance of value, Function - identity, clarify – analysis Evaluation of VE-Evaluation of function, Problem setting system, problem solving system, value analysis case studies, Effective organization for value work, function analysis system techniques- FAST diagram, Case studies. <strong>2.2 Ergonomics :</strong></td>
<td>10</td>
</tr>
</tbody>
</table>
**Introduction:**
Workspace Design - Anthropometry – workspace design for standing and seated workers – Arrangements of components within a physical space – Interpersonal aspect of workplace design.

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<tr>
<th>03</th>
<th>3.1 Human Resource Management</th>
</tr>
</thead>
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<tr>
<th>04</th>
<th>4.1 Human Behaviour</th>
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<tbody>
<tr>
<td></td>
<td>Definition, Factors affecting human behaviour – Genetics, social norms, creativity, attitude, faith and culture, Group and Group behaviour.</td>
</tr>
</tbody>
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<tr>
<th>05</th>
<th>4.2 Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition, Types of theories and models of motivation, Practical Applications of motivation – Employee morale, Employee recognition programs, Drug abuse, Education, Business and work engagement.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>06</th>
<th>5.1 Decision Making</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Introduction, Problem Analysis through Decision making tools, Characteristics of decision making, Steps in Rational decision making.</td>
</tr>
</tbody>
</table>

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<tr>
<th>06</th>
<th>5.2 Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definition, Types, Historical Developments in communication, Barriers to communication, Introduction to Bio-communications, Noise and its types,</td>
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<tr>
<th>06</th>
<th>5.3 Leadership</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Definition, Leadership Theories, Leadership styles, Self – Leadership.</td>
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</tbody>
</table>

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<thead>
<tr>
<th>06</th>
<th>Industrial Relations</th>
</tr>
</thead>
</table>

**Assessment:**

**Internal Assessment for 20 marks:**
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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
End Semester Examination:
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2. Question 1 will be compulsory and should cover maximum contents of the curriculum
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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:

1. *Industrial Engineering and Production Management* - By M. Mahajan, Dhanpat Rai and Co.
7. *Organizational Behaviour*, Text and cases, Uma Sekaran.
10. Micormic, J. “*Human factors in Engineering and Design*”, McGraw Hill,
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEC803</td>
<td>Economics, Finance, Accounting and Costing</td>
<td>04</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To acquaint with the concept of Micro and Macro Economics.
2. To familiarize with the concepts like 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 with the concept of cost records / statements.

**Outcomes:** Learner will be able to...
1. Correlate various micro and macro-economic variables.
2. Analyze various market/business strategies.
3. Illustrate concept of Economic policies and their implications.
4. Demonstrate the roles played by various financial institutions/banks.
5. Analyze various accounting and costing practices.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction</strong>&lt;br&gt;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.</td>
</tr>
<tr>
<td>02</td>
<td><strong>Micro Economics</strong>&lt;br&gt;<strong>Consumer's Behavior:</strong> meaning of utility, marginal utility and law of Diminishing Marginal Utility. Conditions of consumer's equilibrium using marginal utility analysis utility, law of demand and relation between law of demand &amp; law of diminishing marginal utility.&lt;br&gt;<strong>Producer's Behavior:</strong> law of supply, variation in supply, Types of elasticity of supply.&lt;br&gt;<strong>Types of Market:</strong> perfect competition, pure competition, Monopoly.</td>
</tr>
<tr>
<td>03</td>
<td><strong>Macro Economics</strong>&lt;br&gt;<strong>Concept of National Income:</strong> 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.&lt;br&gt;<strong>Economic Policy:</strong> Monetary, Income and Fiscal Policies. 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.</td>
</tr>
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<tr>
<th>Module</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>04</td>
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<tr>
<td>02</td>
<td>04</td>
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<td>03</td>
<td>04</td>
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<td>Page</td>
<td>Topic</td>
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<td>------</td>
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</tr>
<tr>
<td></td>
<td>Working Capital Management:- Concept of working capital management, Cash Conversion Cycle, Management of stock ,overtrading</td>
</tr>
<tr>
<td></td>
<td>Capital Markets Primary Market: Basics of capital market mechanism and instruments.</td>
</tr>
</tbody>
</table>

|      | Management Accounting: Understanding of Financial Statements (Overview), Interpreting Financial statements (overview). |


| Assessment: |

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4. Only Four questions need to be solved
Reference Books:

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.
4. To familiarize with characteristics of business markets, buying situations, trends in industrial marketing and relevant industrial strategies.

Outcomes: Learner will be able to…
1. Design and develop products right from the conceptual level.
2. Demonstrate concept of computer aided product design approach.
3. Illustrate various modern approaches like concurrent engineering, product life cycle management, robust design, rapid prototyping / rapid tooling.
4. Analyze products based on ergonomics and aesthetic aspects.
5. Apply appropriate strategies in industrial marketing.
6. Demonstrate various aspects related to Industrial Marketing Communication, Advertising, Sales promotion, Publicity Media Plan.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 01     | 1.1. **Introduction:** Definition of product design, Classification of products, Design by evolution, Design by innovation, Product Mix, Various phases in product development and Design, Morphology of Design, Considerations in product design, Product specifications.  
1.2. **Conceptual Design:** Market research, Generation, Selection and Embodiment of concept, Product Architecture, Customer centric product designing  
1.3. **Creativity:** Role of creativity in problem solving, Vertical and lateral thinking, Brainstorming, Synectics, Group working dynamics, Adaptation to changing scenarios in economics, social, cultural and technological fronts, Anticipation of new needs and aspirations.  
1.4. **Materials:** Overview of materials including new generation materials, Tailor made material concepts, Material selection process. | 06 |
| 02     | 2.1. **Design for manufacturing (DFM):** Guidelines and Methodology, Producibility requirements, Accuracy and Precision requirements, Strength considerations in Design: Criteria and objectives, Designing for uniform strength, Designing for stiffness and rigidity, Practical ideas for material saving in design - ribs, corrugations, rim shapes, bosses, laminates, etc.  
2.2. **Design for forged and Cast components:** Design for Sheet Metal processed components, powder metallurgical components, Expanded metals and wire forms | 12 |
| 2.3. **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. |
| 2.4. **Other DFX Principles**: Designs for Maintainability, Safety, Reliability, Sustainable Design |
| 2.5. **Design for Assembly (DFA)**: DFA Index, 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. |

| 3.1. **Product Ergonomics**: Anthropometry, Environmental conditions, thermal, noise, vibration, displays, illusions, Psycho and psychological aspects in design, Man-machine information exchange. |
| 3.2. **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. |

| 4.1. **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. |
| 4.2. **Software solutions**: Software for drafting, modeling, assembly, detailing, CAM interfacing, Rapid tooling/rapid prototyping, etc. |
| 4.3. **Modern Applications**: Concurrent Engineering, Robust Design, Additive Manufacturing/Rapid Prototyping, Product Life Cycle Management techniques and application areas. |


| 6.1. **Industrial Marketing Channels**: Channel participants, Channel effectiveness, Marketing logistics, Physical Distribution and Marketing Strategy, Value added market channels |
Assessment:

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4. Only Four questions need to be solved

References Books:

1. Product Design & Development, Karl Ulrich, Steven Eppinger,
3. Design methods inter science, Jomes.
4. Creative Engineering Design, Buhl H. R.
6. Ergonomics, Merilyn Joyce, Ulrika Waller Steiner.
11. Industrial design of plastic products, Gordon, 2003
13. Industrial Marketing Analysis, Planning and control, Robert R Reeder, Edward G Brierty, Betty H Reeder, Prentice Hall India
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>PEDLO8012</td>
<td>World Class Manufacturing</td>
<td>04</td>
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</table>

**Objectives**

1. To familiarize with the concepts of Business excellence and competitiveness.
2. To acquaint with the business challenges and the future manufacturing competition.
3. To acquaint with the current trends of manufacturing scenario at domestic and global level.

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

1. Illustrate relevance and basics of World Class Manufacturing.
2. Co-relate factors of competitiveness and performance measures with respect to benchmarking.
3. Apply productivity tools for world class manufacturing.
5. Analyze the current Status of Indian Manufacturing scenario.
6. Design and develop a roadmap to achieve world class manufacturing status for industries.

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<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>Historical Perspective&lt;br&gt;World class Excellent organizations–Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence.</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td>Benchmark, Bottlenecks and Best Practices&lt;br&gt;Concepts of benchmarking, Bottleneck and best practices, Best performers – Gaining.&lt;br&gt;Competitive edge through world class manufacturing – Value added manufacturing – Value.&lt;br&gt;Stream mapping - Eliminating waste –Toyota Production System – Example.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Typical Characteristics of WCM Companies&lt;br&gt;Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –six Sigma philosophies</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Indian Scenario&lt;br&gt;Case studies on leading Indian companies towards world class manufacturing –Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing with applications of Timers and Counters and concept of Flag and latching.</td>
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</tr>
</tbody>
</table>
Assessment:

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End Semester Examination:
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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 any module other than module 3)
4. Only Four questions need to be solved

Reference Books:
1. Sahay B.S., Saxena KBC. and Ashish Kumar, “World Class Manufacturing – Strategic
learning pvt. Ltd., New Delhi.
5. Ron Moore, “Making Common Sense Common Practice – Models for
Manufacturing excellence”, Butter worth Heinmann.
2002.
Course Code | Course Name | Credits
--- | --- | ---
PEDLO8013 | Logistics and Supply Chain Management | 04

**Objectives:**
1. To acquaint with the concept 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 the 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. Demonstrate the functional strategy map of supply chain management.
2. Design supply chain strategy of a firm.
3. Demonstrate concepts and ideas related to Materials management.
4. Illustrate various aspects pertaining to logistics for any organization.
5. Demonstrate activities of business logistics.
6. Use technology to change logistics and supply chain management.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hours</th>
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<tr>
<td>01</td>
<td>Building a Strategic Framework to Analyse Supply Chains</td>
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</tr>
<tr>
<td>02</td>
<td>Designing the Supply Chain Network</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td>Designing and Planning Transportation Networks</td>
<td>08</td>
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</table>
| 04 | **4.1 Designing Global Supply Chain Networks**  
| 08 | **4.2 Managing Cross-Functional Drivers in a Supply Chain**  
| 05 | **IT in a Supply Chain**  
Information Technology in a Supply Chain: The Role of IT in a Supply Chain, The Supply Chain IT Framework, Customer Relationship Management, Internal Supply Chain Management, Supplier Relationship Management, The Transaction Management Foundation, The Future of IT in the Supply Chain, Risk Management in IT, Supply Chain IT in Practice |
| 06 | **Coordination in a Supply Chain**  
Coordination in a Supply Chain: Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Building Strategic Partnerships and Trust Within a Supply Chain, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning, Forecasting, and Replenishment (CPFR), The Role of IT in Coordination, Achieving Coordination in Practice. Reverse logistics: Reasons, Role, Activities; RFID systems: Components, Applications, Implementation; Lean supply chain, Implementation of Six Sigma in supply chain, Basics of Green supply chain management. |

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4. Only **Four questions need to be solved**
Reference Books:


Objectives:
1. To acquaint with various plant organizing functions.
2. To familiarize with various type of maintenance work and systems in a plant.
3. To acquaint with various methods of pollution control, noise control and vibration control.
4. To acquaint with concept of energy conservation programs.

Outcomes:- Learner will be able to…
1. Illustrate various organization of plant engineering.
2. Apply of heating, ventilating and air conditioning system.
3. Demonstrate process of material handling systems in plant engineering
4. Demonstrate various operational and safety aspects.
5. Illustrate concepts of pollution control, noise control, vibration control and fire control methods.
6. Apply energy conservation programs.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Organization of the plant engineering function, he role of first line supervisor, design of plant engineering organization-Classification of maintenance work, computer based maintenance, predictive maintenance, reliability centered maintenance, integrated system. Standalone system. Ventilation and air-conditioning, Sanitation control and housekeeping. Electric system management, Reliability, power quality, utility rate structures.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Producer Gas Plants-operation and safety aspects in P.G. Compressor and Oxygen plants.</td>
<td>04</td>
</tr>
<tr>
<td>03</td>
<td>Applications of heating, ventilating and air conditioning system-General considerations, occupancies, exhaust systems. Communication and computer networks- The network, hardware, backing up data. peripherals, environment, security</td>
<td>04</td>
</tr>
<tr>
<td>04</td>
<td>Material handling Planning Solving material handling problems, justification of material handling projects. Material handling containerization-AS and RS (Automatic Storage and Retrieval System)-AGV and robotics-piping system design and components- Pollution control Regulatory requirement, emission safety, emission control methods and plant safety Lighting Determining lighting criteria, determining light source requirement, utilize multiple designs</td>
<td>10</td>
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<tr>
<td>05</td>
<td>Noise control – Occupational noise control limits, occupational hearing conservation requirement, Human response to noise, control of plant noise, computer modelling, measurement and instrumentation. Vibration control-</td>
<td>10</td>
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<tr>
<td>06</td>
<td><strong>Characterization of vibrations, causes of vibrations, effects of vibration, the need for vibration control, vibration control strategy.</strong></td>
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</table>
|    | **Fire control**  
The nature of fire, The plant fire problem: causes and prevention, plant fire hazards, fire hazards of materials, design and construction for fire safety, fire detection and alarm system, special agent suppression systems, portable fire extinguishers, codes and standards. |
| 10 | **Energy Conservation**-  
Energy conservation program preparation. Determining energy conservation potential, refining the problem, implementation, savings maintenance.  
**Lubrication and corrosion**-  
Synthetic and solid lubricants -lubrication systems - causes and control deterioration - paints and protective coatings |

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4. Only **Four questions need to be solved**

**Reference Books:**

Objectives:
1. To familiarize with various measuring instruments and methods of measurements of important process parameters.
2. To acquaint with the principles of automation and automatic process control techniques.
3. To familiarize with concepts of measurement and automatic process control related to specific industrial applications.

Outcomes: Learner will be able to…
1. Illustrate basic principles of working and error estimation of measuring instruments.
2. Select various measuring instruments.
3. Illustrate basics of automatics control and control modes.
4. Measure process parameters.
5. Apply automatic process control approaches to various industrial application areas.
6. Identify Industrial applications of process control techniques.

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<tr>
<th>Module</th>
<th>Contents</th>
<th>Hrs</th>
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<tbody>
<tr>
<td>01</td>
<td>Basics of instruments: Types of measurements, classification, types of measuring instruments, constructional and design features, performance characteristic. Generalised configuration of a measurement systems.</td>
<td>05</td>
</tr>
</tbody>
</table>
| 02 | Measurements of process parameters (Temperature and pressure):  
2.2 Pressure measurement: pressure sensors, Elastic Electrical and Inductance type pressure transducers, Barometer, Manometers – Types and comparisons, Differential pressure measurement, vacuum measurement, Pressure gauges – Types. | 10 |
| 03 | Measurements of Process Parameters (Level, Flow, and Humidity)  
3.1 Level and density Measurement: Direct Level measurement – Point contact, Gauge glass and buoyancy methods. Indirect Level measurement – Hydrostatic, capacitance, radiation and ultrasonic methods. Density measurement techniques.  
3.3 Humidity measurement: measurement of humidity using psychometer and hygrometer (Mechanical and Electrical types), Moisture measurement in solids. | 10 |
| 04 | **Automatic process control:** Fundamentals of automatic process control, Process dynamics – process response, process time tags, types of lags- capacitance, resistance, transportation and inertia lag. Process classification – first order and second order systems. | 06 |
| 05 | **Automatic control and control modes:**
| | **5.1 Automatic control:** block diagram, feedback and feedback forward control, servo and regulator operations, Controlling of batch and continuous process.
| | **5.2 Control modes:** classification of controllers, ON-OFF control; Proportional (P) control; Integral (I) control; Differential (D) control; P & I control; P & D control; P, I & D control, Selection of control modes. ISA (instrumentation society of America) codes and flow-plan symbols; Typical instrumentation symbols. | 10 |
| 06 | **Industrial Application of process control:** Examples of control systems used for measurement and control of – Temperature, Pressure, Level and Flow. Ratio Control and Cascade control. Alarm systems and indications, Basic concepts of telemetry and telecontrol of operations. | 07 |

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4. Only **Four questions need to be solved**

**Reference Books:**
1. *Fundamentals of industrial instrumentation and process control*, William C. Dunn, TMH.
4. *Instrumentation for process measurement and control*, Anderson, Taylor and Francis Publisher.
5. *Process control*, Peter Harriott, TMH.
Objectives:
1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...
1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Project Management Foundation:</strong> Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical &amp; atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)</td>
<td>5</td>
</tr>
<tr>
<td>02</td>
<td><strong>Initiating Projects:</strong> How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development &amp; growth (forming, storming, norming &amp;performing), team dynamics.</td>
<td>6</td>
</tr>
<tr>
<td>03</td>
<td><strong>Project Planning and Scheduling:</strong> Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).</td>
<td>8</td>
</tr>
<tr>
<td>04</td>
<td><strong>Planning Projects:</strong> Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks</td>
<td>6</td>
</tr>
<tr>
<td>05</td>
<td><strong>5.1 Executing Projects:</strong> Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings <strong>5.2 Monitoring and Controlling Projects:</strong> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit <strong>5.3 Project Contracting</strong> Project procurement management, contracting and outsourcing,</td>
<td>8</td>
</tr>
</tbody>
</table>
6.1 Project Leadership and Ethics:
Introduction to project leadership, ethics in projects, Multicultural and virtual projects

6.2 Closing the Project:
Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.

Assessment:

Internal Assessment for 20 marks:
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First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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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 any module other than module 3)
4. Only Four questions need to be solved

REFERENCES:

1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
Objectives:
1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</td>
<td>09</td>
</tr>
<tr>
<td>04</td>
<td>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity’s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity’s Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure</td>
<td>05</td>
</tr>
</tbody>
</table>
Assessment:

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4. Only Four questions need to be solved.

REFERENCES:

## Course Code: ILO8023
### Course Name: Entrepreneurship Development and Management
### Credits: 03

### Objectives:
1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

### Outcomes:
Learner will be able to:
1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td>Indian Environment for Entrepreneurship: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business</td>
<td>05</td>
</tr>
</tbody>
</table>

### Assessment:

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4. Only Four questions need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in
Course Code | Course Name         | Credits |
------------|---------------------|---------|
ILO8024     | Human Resource Management | 03      |

Objectives:
1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Outcomes: Learner will be able to…
1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today’s emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to HR</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues</td>
<td></td>
</tr>
</tbody>
</table>

| 02     | Organizational Behaviour (OB) | 7   |
|        | Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues |
|        | Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness |
|        | Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour |
|        | Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); |
|        | Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. |
|        | Case study |

| 03     | Organizational Structure &Design | 6   |
|        | Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. |
|        | Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. |
|        | Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. |
Human resource Planning
- Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale
- Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning
- Training & Development: Identification of Training Needs, Training Methods

Emerging Trends in HR
- Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment
- Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation

HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)

Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals

Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act

Assessment:

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REFERENCES:
**Course Code** | **Course Name** | **Credits**
--- | --- | ---
ILO8025 | Professional Ethics and Corporate Social Responsibility (CSR) | 03

**Objectives:**
1. To understand professional ethics in business
2. To recognize corporate social responsibility

**Outcomes:** Learner will be able to…
1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td>Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm’s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td>Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India</td>
<td>05</td>
</tr>
<tr>
<td>05</td>
<td>Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.</td>
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REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
# Course Code
**ILO8026**

# Course Name
**Research Methodology**

<table>
<thead>
<tr>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>03</td>
</tr>
</tbody>
</table>

## Objectives:
1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

## Outcomes:
Learner will be able to:
1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

## Module | Detailed Contents | Hrs
--- | --- | ---
01 | **Introduction and Basic Research Concepts** | 09
1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology
1.2 Need of Research in Business and Social Sciences
1.3 Objectives of Research
1.4 Issues and Problems in Research
1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical

02 | **Types of Research** | 07
2.1. Basic Research
2.2. Applied Research
2.3. Descriptive Research
2.4. Analytical Research
2.5. Empirical Research
2.6 Qualitative and Quantitative Approaches

03 | **Research Design and Sample Design** | 07
3.1 Research Design – Meaning, Types and Significance
3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors

04 | **Research Methodology** | 08
4.1 Meaning of Research Methodology
4.2. Stages in Scientific Research Process:
  a. Identification and Selection of Research Problem
  b. Formulation of Research Problem
  c. Review of Literature
  d. Formulation of Hypothesis
  e. Formulation of research Design
  f. Sample Design
  g. Data Collection
  h. Data Analysis
  i. Hypothesis testing and Interpretation of Data
  j. Preparation of Research Report

05 | **Formulating Research Problem** | 04
5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis

06 | **Outcome of Research** | 04
6.1 Preparation of the report on conclusion reached

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*University of Mumbai, B. E. (Production Engineering), Rev 2016*
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REFERENCES:
### Course Code | Course Name | Credits
---|---|---
ILO8027 | IPR and Patenting | 03

**Objectives:**
1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

**Outcomes:** Learner will be able to…
1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

<table>
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<tr>
<th>Module</th>
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<tbody>
<tr>
<td><strong>01</strong></td>
<td><strong>Introduction to Intellectual Property Rights (IPR):</strong> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. <strong>Importance of IPR in Modern Global Economic Environment:</strong> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</td>
<td>05</td>
</tr>
<tr>
<td><strong>02</strong></td>
<td><strong>Enforcement of Intellectual Property Rights:</strong> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement <strong>Indian Scenario of IPR:</strong> Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.</td>
<td>07</td>
</tr>
<tr>
<td><strong>03</strong></td>
<td><strong>Emerging Issues in IPR:</strong> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.</td>
<td>05</td>
</tr>
<tr>
<td><strong>04</strong></td>
<td><strong>Basics of Patents:</strong> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent</td>
<td>07</td>
</tr>
<tr>
<td><strong>05</strong></td>
<td><strong>Patent Rules:</strong> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)</td>
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<tbody>
<tr>
<td>ILO 8028</td>
<td>Digital Business Management</td>
<td>03</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

**Outcomes:** The learner will be able to …..
1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

<table>
<thead>
<tr>
<th>Module</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction to Digital Business</strong> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, <strong>Drivers of digital business</strong> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,</td>
<td>09</td>
</tr>
<tr>
<td>2</td>
<td><strong>Overview of E-Commerce</strong> E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC</td>
<td>06</td>
</tr>
<tr>
<td>3</td>
<td><strong>Digital Business Support services:</strong> ERP as e–business backbone, knowledge Top Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure</td>
<td>06</td>
</tr>
<tr>
<td>6</td>
<td><strong>Materializing e-business:</strong> From Idea to Realization** Business plan preparation Case Studies and presentations</td>
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References:

2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
Course Code | Course Name | Credits
--- | --- | ---
ILO8029 | Environmental Management | 03

**Objectives:**
1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

**Outcomes:** Learner will be able to…
1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

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<tr>
<th>Module</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td>Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td>Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Total Quality Environmental Management, ISO-14000, EMS certification.</td>
<td>05</td>
</tr>
<tr>
<td>06</td>
<td>General overview of major legislations like Environment Protection Act, Air (P &amp; CP) Act, Water (P &amp; CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.</td>
<td>03</td>
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REFERENCES:

2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
Objectives:
1. To familiarize with software based pneumatics, electro-pneumatics and PLC circuits’ simulation.
2. To familiarize with setup and execution of pneumatics, electro-pneumatics and PLC circuits on an experimental kit.

Outcomes: The learner will be able to…
1. Design & Simulate Pneumatic, Electro-Pneumatic and PLC based circuits on any compatible software.
2. Setup and execute Pneumatic, Electro-Pneumatic and PLC based circuits on an experimental kit.
3. Design & Simulate PLC based circuits (Ladder Diagram) on any compatible software.
4. Set up and execute Pneumatic circuits on an experimental kit.
5. Set up and execute electro-pneumatic circuits on an experimental kit.
6. Set up and execute PLC based circuit on an experimental kit.

<table>
<thead>
<tr>
<th>Sr no</th>
<th>Circuit Design/Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Designing &amp; Simulation of two pneumatic circuits on any compatible software.</td>
</tr>
<tr>
<td>02</td>
<td>Designing &amp; Simulation of two electro-pneumatic circuits on any compatible software.</td>
</tr>
<tr>
<td>03</td>
<td>Designing &amp; Simulation of two PLC based circuits (Ladder Diagram) on any compatible software.</td>
</tr>
<tr>
<td>04</td>
<td>Two Pneumatic circuits Setup and execution on experimental kit.</td>
</tr>
<tr>
<td>05</td>
<td>Two Electro-Pneumatic circuits Setup and execution on experimental kit.</td>
</tr>
<tr>
<td>06</td>
<td>Two PLC based circuits Setup and execution on experimental kit.</td>
</tr>
</tbody>
</table>

Term Work:
Term work shall consist of exercises listed in the above list
The distribution of marks for term work shall be as follows:

- Circuit Simulation: 10 marks
- Circuit Setup and Execution: 10 marks
- Attendance: 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.
**Practical/Oral Exam:**

The practical/Oral exam shall consists of the following:

- Circuit Simulation: one problem : **15** marks
- Circuit Setup and Execution: one problem : **10** marks
Course Code | Course Name | Credits
--- | --- | ---
PEL802 | Industrial Engineering and Human Resource Management Laboratory | 01

**Objectives**
1. To familiarize with the concepts like Design, develop, implement, and improve integrated systems.
2. To acquaint with basic philosophy of enhancing effectiveness of the human resource potential of their organization.

**Outcomes** learner will be able to…
1. Apply different industrial engineering principles for productivity enhancement.
2. Develop an integrated systems.
3. Develop skills in identifying, planning, and deploying of man power.
4. Develop inter personal and soft skills.
5. Develop skills in identifying training needs of employes at different levels.
6. Apply legal aspects of employment.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>List of Assignments (any Five assignments)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exercise on Decision Making process in solving a chosen problem.</td>
</tr>
<tr>
<td>2</td>
<td>Exercise on a Case analysis of Human Behavior at work place.</td>
</tr>
<tr>
<td>3</td>
<td>Exercise on any one of the Time Measurement techniques.</td>
</tr>
<tr>
<td>4</td>
<td>Exercise on Assessment of Leadership Quality.</td>
</tr>
<tr>
<td>5</td>
<td>Exercise on a case study on Value Analysis.</td>
</tr>
<tr>
<td>6</td>
<td>Exercise on Ergonomic Design of a part / product.</td>
</tr>
<tr>
<td>7</td>
<td>Presentation on current scenario of Industrial Relations.</td>
</tr>
</tbody>
</table>

**Term Work**
Term work shall consist of at least 5 assignments from above list.
The distribution of marks for term work shall be as follows:
- Assignments : 20 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.

**Oral Examination**
1. Examiners are expected to evaluate learner’s practical understanding of fundamental skills involved in the field of Industrial Engineering as well his/her grasp of the knowledge of Human Resources, being a very crucial and critical resource in modern firms. The oral examination should be conducted broadly based on the practical significance of the syllabus.
2. The distribution of marks for oral examination shall be as follows:
3. Oral …… ........................ 25 marks
Course Code | Course Name | Credits
--- | --- | ---
PHEL803 | Economics, Finance, Accounting and Costing Tutorial | 01

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

**Outcomes:** Learner should 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.
6. Get an exposure to wider intricacies of financial management.

**List of Assignments**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>List of Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>An assignment on Micro and Macro Economics.</td>
</tr>
<tr>
<td>02</td>
<td>An assignment on Financial Management.</td>
</tr>
<tr>
<td>03</td>
<td>An assignment on Job Costing</td>
</tr>
<tr>
<td>04</td>
<td>Assignment on Marginal Costing.</td>
</tr>
<tr>
<td>05</td>
<td>Assignment on Standard Costing.</td>
</tr>
<tr>
<td>06</td>
<td>Assignment on Process Costing.</td>
</tr>
</tbody>
</table>

One assignment each on the above mentioned list of assignments and a Mini Project based on the syllabus in the subject of Economics, Finance, Accounting and Costing. Students have to present the mini project in a group of 3-4. Some areas suggested are as follows:-

a. Study of annual report and final accounts of a company (currently active) and comment upon the financial aspects of the firm.

b. Making of a profit & loss statement and Balance sheet of any firm using hypothetical data /actual data and presentation of same.

c. Any other mini project based on the subject syllabus.

Assignments : 10 Marks
Mini Project : 10 Marks
Attendance : 05 Marks
Total : 25 Marks