CIRCULAR:-

A reference is invited to the syllabus relating to the Master of Engineering (M. E) degree course vide this office Circular No.UG/24 of 2013-14, dated 21st July, 2013 and the Principals of affiliated Colleges in Engineering, hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 vide item No. 4.70 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) (Product Design and Development) (Sem. I to IV), which is available on the University’s website (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032

To,

The Principals of affiliated Colleges in Engineering.

A.C/4.70/14/07/2016.

***************

No. UG/219 -A of 2016-17 MUMBAI-400 032 12–January, 2017

Copy forwarded with compliments for information to:-

1. The Co-Ordinator, Faculty of Technology,
2. The Chairmen/Chairpersons of various Board of the Studies in Engineering and Technology.
3. The Director, Board of College and University Development.
4. The Controller of Examinations,
5. The Co-Ordinator, University Computerization Centre.

(Dr.M.A.Khan)
REGISTRAR

... PTO
UNIVERSITY OF MUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

PRODUCT DESIGN AND DEVELOPMENT

(As per Choice Based Credit and Grading System with effect from the academic year 2016–2017)
From Co-ordinator’s Desk:-
To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated 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 meetings unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEOs), give freedom to Affiliated Institutes to add few (PEOs), course objectives course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth of 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 are 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, **Choice 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. Faculty of Technology has devised a transparent credit assignment policy, adopting a ten point scale to grade learner’s performance. Choice Based Credit and Grading System is implemented for Master of Engineering from the academic year 2016-2017.

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

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

In addition to the above, 2 to 3 more program educational objectives of their own may be added by affiliated Institutes.

In addition to Program Educational Objectives, for each course of postgraduate 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 stake holders.

Dr. S. M. Khot
Chairman, Board of Studies in Mechanical Engineering, University of Mumbai
# Program Structure for ME Mechanical Engineering (Product Design and Development)  
**Mumbai University**  
(With Effect from 2016-2017)

## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits Assigned</th>
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<td>Product Design and Development</td>
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University of Mumbai, ME (Mechanical) Product Design and Development, Rev 2016 7
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³Seminar of Semester III and Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners

Note-  The Contact Hours for the calculation of load of teacher are as follows
   Seminar   - 01 Hour / week / student
   Project I and II - 02 Hour / week / student
Objectives
1. To study the basic concepts of product design and development process.
2. To study the applicability of product design and development in industrial applications.
3. To study the key reasons for design or redesign.

Outcomes: Learner will be able to…
1. Select an appropriate product design and development process for a given application.
2. Choose an appropriate ergonomy for the product.
3. Select an appropriate standardisation method.
4. Develop the methods to minimise the cost.

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<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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<tr>
<td>01</td>
<td>1.1 Introduction: Classification/ Specifications of Products.</td>
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<td>1.2 Product life cycle. Product mix.</td>
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<td>1.3 Introduction to product design.</td>
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<td>1.4 Modern product development process.</td>
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<td>1.5 Innovative thinking.</td>
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<td>1.6 Morphology of design.</td>
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<td>2.1 Conceptual Design: Generation, selection &amp; embodiment of concept.</td>
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<tr>
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<td>2.2 Product architecture.</td>
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<td>2.3 Industrial design: process, need.</td>
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<td>2.4 Robust Design: Taguchi Designs &amp; DOE.</td>
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<td>3.2 Designs for Maintainability.</td>
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<td>3.3 Designs for Environment.</td>
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<td>3.4 Product costing.</td>
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<td>3.5 Legal factors and social issues. Engg ethics and issues of society related to design of products.</td>
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<td>04</td>
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<td>4.3 Economic analysis: Qualitative &amp; Quantitative.</td>
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<td>05</td>
<td>5.1 Ergonomics / Aesthetics: Gross human autonomy.</td>
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<td>5.2 Anthropometry.</td>
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<td>5.3 Man-Machine interaction.</td>
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<td>5.4 Concepts of size and texture, colour. Comfort criteria.</td>
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<td>5.5 Psychological &amp; Physiological considerations.</td>
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<td>5.6 Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.</td>
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<td>6.1 Concurrent Engg.</td>
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<td>6.2 Rapid prototyping.</td>
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<td>6.3 Tools for product design – Drafting / Modeling software.</td>
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Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed 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. L D Miles “Value Engineering.”
<table>
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**Objectives**
1. To Familiarise students with rapid prototyping and tooling technologies.
2. To study basic concepts of reverse engineering and their application in product development.
3. To study advanced manufacturing techniques.

**Outcomes:** Learner will be able to…
1. Communicate with community and professional environment about RPT
2. Classify and select proper rapid prototyping and reverse engineering techniques for specific technical applications.
3. Use detailed knowledge in the field of selected advanced manufacturing methods. Moreover inspection methods concerning quality of manufactured prototypes are introduced too.
4. Utilize basic reverse engineering technologies, programing and operating sophisticated technical equipment.
5. Think and work in creative and entrepreneur way with giving consideration of economic aspect

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<td>• Applications: Design, Planning, Manufacturing and Tooling</td>
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<td>• Applications: Automotive, Jewelry, Coin and Bio-Medical</td>
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<td>• Fundamentals of Rapid Prototyping, Design Process</td>
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<td><strong>Subsystems of RP Machine</strong></td>
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<td>o Computer Interfacing hardware, DAQs</td>
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<td></td>
<td>o Signal Flow, 3D Model to RP Prototype</td>
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<td></td>
<td>• Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.)</td>
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<td>• Slicing and Scan Path Generation Algorithms</td>
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<td>• Data Conversion and Transmission</td>
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<td>• File Formats, IGES, STL</td>
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<td></td>
<td>• Preprocessing and Post-processing</td>
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<td>03</td>
<td><strong>Liquid Based Rapid Prototyping Systems</strong></td>
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<td>• Materials</td>
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<td></td>
<td>• Stereolithography</td>
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<td>• Solid Ground Curing</td>
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<td>• Solid Object UV (Ultra-Violet) Printer</td>
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<td></td>
<td>• Two Laser System</td>
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<td>• Micro-stereolithography</td>
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<td>04</td>
<td><strong>Solid Based Rapid Prototyping Systems</strong></td>
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<td>• Materials</td>
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<td></td>
<td>• LOM (Laminated Object Manufacturing) System</td>
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<td>• FDM (Fuse Deposition Modeling) System</td>
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<td>• Multi-Jet Modeling (MJM) System</td>
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<td>• Model Maker and Pattern Master</td>
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<td>• Shape Deposition Manufacturing Process</td>
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<td>05</td>
<td>Powder Based Rapid Prototyping Systems</td>
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<td></td>
<td>• Materials</td>
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<td></td>
<td>• SLS (Selective Laser Sintering)</td>
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<tr>
<td></td>
<td>• (3DP) Three-Dimensional Printing</td>
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<td></td>
<td>• (LENS) Laser Engineered Net Shaping</td>
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<td></td>
<td>• (MJS) Multiphase Jet Solidification</td>
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<td></td>
<td>• (EBM) Electron Beam Melting</td>
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<tr>
<th>06</th>
<th>Advances in RP Systems and Case Studies</th>
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<tbody>
<tr>
<td></td>
<td>• Case Study: Wind-Tunnel Testing with RP Models</td>
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<td></td>
<td>• Case Study: Investment Casting with RP</td>
</tr>
</tbody>
</table>

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2. All question carry equal marks
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4. Only Four questions need to be solved.

**References:**

Objective
1. To expose the students to the material aspects of Product design.
2. To study importance of material in Process modeling and design for assembly
3. To expose the students to new material processing techniques

Outcomes: Learner will be able to...
1. Understand the behavior of various metals and non-metals
2. Learn about the selection of material for different applications
3. Get exposure to the manufacturing processes in micro fabrication

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Material Behavior And Selection</td>
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<tr>
<td>02</td>
<td>Process Modeling And Product Design</td>
</tr>
<tr>
<td>03</td>
<td>Non Metals And Manufacturing</td>
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<tr>
<td>04</td>
<td>Product Design And Assembly Requirements</td>
</tr>
<tr>
<td></td>
<td>Structural product analysis- End use behaviour- Effect of tooling in product design-Design for joining and assembling- Design for live hinges- Snap fits, design of corners,bushes and ribs- Design considerations- New product design- Methods of decoration-Bonding and cementing techniques- Thermal bonding- Machining of plastics-Parameters and effect- Case studies in material selection with relevance to product design and development</td>
</tr>
<tr>
<td>05</td>
<td>Development In Materials Processing</td>
</tr>
<tr>
<td></td>
<td>Micro fabrication technologies- Tool for micro fabrication- Diamond and high speed machining- LIGA micro fabrication process- Multilayer X-ray lithography-</td>
</tr>
</tbody>
</table>
Introduction to Smart / Intelligent Materials:
Overview of Smart / Intelligent Materials, Primitive Functions of Intelligent Materials, Intelligence Inherent in Materials, Actuator Materials, Sensing Technologies, Micro-sensors, Intelligent Systems, Hybrid Smart Materials, Passive Sensory Smart Structures, Reactive Actuator based Smart Structures, Active Sensing and Reactive Smart Structures, Smart Skins

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4. Only Four questions need to be solved.

References:
4. Harfold Belofsky- Plastic design and processing hand book, Hanser publication- 2005
## Course Code: PDDDLO 1011
### Course Name: Computer Aided Product Development
### Credits: 04

**Objectives**
1. To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc

**Outcomes:** Learner will be able to...
1. Get familiarized with the computer graphics application in design
2. Understand 3D modeling application in product development.
3. Solve CAE problems that arise in engineering

<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>Introduction to computer Graphics</strong>: Definitions, Classification, Architecture of interactive computer Graphics, Applications Display &amp; Interactive devices <strong>Scan Conversion</strong>: Pixel plotting, scan conversion of Line, Circle, ellipse, Parabola, Hyperbola. Effects of Scan conversion Polygons: Types, Polygon filling using Boundary fill, edge fill, Flood fill algorithms, Scan conversion with Real Time scan conversion, Run length encoding, Cell encoding</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Graphics Programming</strong>: Graphics function, open GL interface, Co-ordinate systems, Primitives &amp; Attributes <strong>Transformations</strong>: 2-D Transformations, 3-D Geometric &amp; modeling Transformations</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>2-D Viewing &amp; Clipping, 3-D Viewing &amp; Clipping, 3D viewing functions <strong>Projection</strong>: General Projection Transformation, parallel &amp; Perspective Projections</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Curves</strong>: Splines, Bezier &amp; B-Spline Curves <strong>Surfaces</strong>: Visible Surface detection methods, Hermite, Bezier &amp; B-Spline surfaces</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Virtual Reality</strong>: Hidden Lines &amp; Hidden Surfaces: Z-Buffer, Painters, Ray Tracing, Area- Subdivision, Scan Line algorithm Light, Color &amp; Shading Models Animation.</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td><strong>CAD &amp; Geometric Modeling</strong>: Features of Modeling &amp; Assembly Packages, Types of Geometric Modeling, geometry &amp; topology, Data Structures, and Product Data exchange Formats. <strong>Fundamentals of CAE</strong>: General procedures of Numerical methods like FEM &amp; FDM, Kinematic analysis &amp; Animation, Features and Application of Commercial packages of CAE.</td>
<td>08</td>
</tr>
</tbody>
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References:

2. Computer graphics by Zhigang Xiang & Roy Plastock (Schaum’s outline’s)
4. Mathematical elements for Computer Graphics by David F. Rogers, James Alan Adams
5. Procedural elements for Computer Graphics by David F. Rogers, James Alan Adams
6. Mastering CAD/CAM by Ibrahim Zeid
7. Geometric Modelling by Mortenson, M.E.
Objectives
1. To highlight the importance of creativity for new product development
2. To study skills needed for enhancing creative thinking and encouraging innovation.

Outcomes: Learner will be able to…
1. Understand the various techniques adopted for stimulating creativity
2. Apply innovative process to the design and development of new products

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>INTRODUCTION:</td>
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<td></td>
<td>Need for design creativity – creative thinking for quality – essential theory about directed creativity</td>
<td>10</td>
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<tr>
<td>02</td>
<td>MECHANISM OF THINKING:</td>
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<td></td>
<td>Definitions and theory of mechanisms of mind heuristics and models: attitudes, Approaches and Actions that support creative thinking</td>
<td>14</td>
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<tr>
<td>03</td>
<td>VISUALIZATION:</td>
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<td></td>
<td>Advanced study of visual elements and principles- line, plane, shape, form, pattern, texture gradation, color Symmetry. Spatial relationships and compositions in 2 and 3 dimensional space - procedure for genuine graphical computer animation – Animation aerodynamics – virtual environments in scientific Visualization – Unifying principle of data management for scientific visualization - Visualization benchmarking</td>
<td>09</td>
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<tr>
<td>04</td>
<td>CREATIVITY:</td>
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<td>Methods and tools for Directed Creativity – Basic Principles – Tools of Directed Creativity – Tools that prepare the mind for creative thought – stimulation of new ideas – Development and Actions: - Processes in creativity ICEDIP – Inspiration, Clarification, Distillation, Perspiration, Evaluation and Incubation – Creativity and Motivation The Bridge between man creativity and the rewards of innovativeness – Applying Directed Creativity to the challenge of quality management</td>
<td>08</td>
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<td>05</td>
<td>DESIGN:</td>
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<td></td>
<td>Process Design, Emotional Design – Three levels of Design – Viceral, Behavioral and Reflective- Recycling and availability-Creativity and customer needs analysis – Innovative product and service designs, future directions in this application of creativity thinking in quality management</td>
<td>07</td>
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<tr>
<td>06</td>
<td>INNOVATION:</td>
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References:

2. Geoffrey Petty,” how to be better at Creativity”, The Industrial Society 1999
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<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Manufacturing Process:</strong></td>
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<td></td>
<td>Shearing, Mechanics of Shearing, Shearing Forces, Blanking and Punching Mechanisms,</td>
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<td></td>
<td>Bending, Mechanics of Deep Drawing, Various Forming Processes such as Stretch</td>
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<td>Forming, Nosing, Expanding, Dimpling, Spinning, Flexible Die Forming, Basic Die</td>
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<td>Classifications and Components</td>
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<td>02</td>
<td><strong>Tool and Die Materials:</strong></td>
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<td>Carbon and Alloy Steels, Designations for Carbon and Alloy Steels, Effects</td>
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<td></td>
<td>of Various Alloy Elements in Steels, Carbon Steels, Alloy Steels, Machinability</td>
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<td>of Steels, Mechanical Properties of Steels, Applications of Carbon and Alloy</td>
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<td>Steels, Tool and Die Steels, Designation and Classification of Tool and Die</td>
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<td>Steels, Cold Work Tool and Die Steels, Nonferrous Metals, Non-metallic Materials</td>
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<td>03</td>
<td><strong>Design of Blanking and Punching Dies:</strong></td>
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<td>Die Blocks, Die Opening Profile, Fastening to the Die Shoe, Sectioned Die,</td>
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<td>Calculation of Die Block Dimensions, Punches, Punch Face, Geometry, Methods for</td>
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<td>Assembling Punches, Punch Calculations, Stripper Plates, Stripper Force, Stripper</td>
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<td>Force, Stripper Design, Die Components for Guiding and Stopping, Stock Guides</td>
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<td>and Guide Rails, Die Stops and French Notch Punch, Positioning the Individual</td>
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<td>Blank, Pilots, Centre of Die Pressure, Examples of Counting Die Designs</td>
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<td>04</td>
<td><strong>Design of Bending Dies:</strong></td>
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<td>Simple Die Designs, U-Profile Bend Dies, V-profile Bend Dies, Universal Bending</td>
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<td>Dies, Dies of Complex Design, Closing Profile Dies, Special Bending Dies, Curling</td>
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<td>and Hinge Dies, Tube-forming Dies, Multiple-bend Dies, Combination Dies,</td>
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<td>Progressive Dies</td>
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<td>05</td>
<td><strong>Deep Drawing Dies:</strong></td>
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<td>Draw Rings, Draw Rings with Corner Radius, Draw Rings with Conical Profile,</td>
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<td>Clearances and Tolerances, Calculation of the Dimensions of the Punch and Die,</td>
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<td>Blank Holders, Blank Holder Pressure, Blank Holder Force, Draw Beads, Single-</td>
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<td>operation Dies, Multi-operation Dies, Progressive Dies, Ironing Dies, Drawing</td>
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<td>Dies for Pieces</td>
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<td>06</td>
<td><strong>Various Forming Dies:</strong></td>
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<td>Nosing Dies, Expanding and Bulging Dies, Expanding Dies, Bulging Dies, Flanging</td>
<td>06</td>
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<tr>
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<td>Dies</td>
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<td><strong>Die Process Quality And Automation, Die Maintenance:</strong></td>
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<td>Limit Switches, Sensors, Vision Control, Automation and In-Die Processes,</td>
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<td>Automated Quality Control, Die Maintenance and Adjustments, Role of</td>
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<td>Software’s in Die Design</td>
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References:

**Course Code**: PDDLO1014  
**Course Name**: Product Packaging  
**Credits**: 04

**Objectives**
1. To study the importance of product packaging in new product development.
2. To study skills needed to creative packaging for new products.

**Outcomes**: Learner will be able to…
1. To understand the various techniques for packaging for a new product.
2. To apply quality assessment and testing techniques to the design and development of new products.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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</thead>
</table>
| 01     | Introduction: Definition  
Functions of Packaging, package environment Product & Packaging, Material Characteristics, Packaging Evaluation. | 10 |
| 02     | Packaging Media (Science, Technology, Manufacture, Conversion, Properties & Applications):  
Paper & Board, Fibre Board Boxes, Composite Containers, Drums, Celluloses, Glass, Metal Containers and Components, Polymers and Plastics, Flexible Packaging Materials, Wooden Containers, Crates, IBCs, Flexible & Rigid, Textiles and Jute. | 09 |
| 03     | Quality Assessment & Performance Evaluation:  
| 04     | Package Printing:  
Pre-Press, Printing Processes, Letterpress, Offset, Lithography, Flexography, Gravure, Screen, Pad, Foil Stamping, Digital Printing (Inkjet, Thermal), Computer-to-Plate. Colour Management, Colour Measurement, etc. | 10 |
| 05     | Package Graphics:  
Package Design, Role of Graphics, Package Aesthetics, Decoration Aspects, Layout and Feature Selection, etc. | 07 |
| 06     | Package Storage and Handling:  
Storage Types, Damage Control, Warehousing and Handling Equipments & Techniques, etc. | 09 |
|        | Packaging & Environment:  
Eco Issues, Wastage Control, Wastage Disposal, Eco Friendly Packaging, etc. | 09 |
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References:

### Course Code: ILO 1011  
### Course Name: Product Life Cycle Management  
### Credits: 03

#### Objectives:
1. To familiarize the students with the need, benefits and components of PLM  
2. To acquaint students with Product Data Management & PLM strategies  
3. To give insights into new product development program and guidelines for designing and developing a product  
4. To familiarize the students with Virtual Product Development

#### Outcomes:
1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.  
2. Illustrate various approaches and techniques for designing and developing products.  
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.  
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

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<tr>
<th>Module</th>
<th>Detailed Contents</th>
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</thead>
</table>
| 01     | **Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications  
**PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM | 10 |
| 03     | **Product Data Management (PDM):** Product and Product Data, PDM systems and importance. Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation | 05 |
| 04     | **Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies | 05 |
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REFERENCES:

**Course Code**: ILO 1012  
**Course Name**: Reliability Engineering  
**Credits**: 03

**Objectives:**
1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

**Outcomes:** Learner will be able to…
1. Apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
</table>
| 01     | **Probability theory**: Probability: Standard definitions and concepts; Conditional Probability, Baye’s Theorem.  
**Probability Distributions**: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.  
**Measures of Dispersion**: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis. | 08 |
| 02     | **Reliability Concepts**: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.  
**Failure Data Analysis**: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.  
**Reliability Hazard Models**: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis. | 08 |
| 03     | **System Reliability**: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. | 05 |
| 04     | **Reliability Improvement**: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.  
System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method. | 08 |
| 05     | **Maintainability and Availability**: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement.  
Availability – qualitative aspects. | 05 |
| 06     | **Failure Mode, Effects and Criticality Analysis**: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis | 05 |
Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
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1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
Objectives:
1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today’s business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…
1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.</td>
<td>4</td>
</tr>
<tr>
<td>02</td>
<td>Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results</td>
<td>7</td>
</tr>
<tr>
<td>03</td>
<td>Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls</td>
<td>7</td>
</tr>
<tr>
<td>05</td>
<td>Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.</td>
<td>6</td>
</tr>
</tbody>
</table>

Assessment:

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4. Only Four question need to be solved.
REFERENCES:
1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
Course Code | Course Name | Credits |
---|---|---|
ILO 1014 | Design of Experiments | 03 |

**Objectives:**

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

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

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
<tbody>
<tr>
<td><strong>01</strong></td>
<td><strong>Introduction</strong>&lt;br&gt; 1.1 Strategy of Experimentation&lt;br&gt; 1.2 Typical Applications of Experimental Design&lt;br&gt; 1.3 Guidelines for Designing Experiments&lt;br&gt; 1.4 Response Surface Methodology</td>
<td>06</td>
</tr>
<tr>
<td><strong>02</strong></td>
<td><strong>Fitting Regression Models</strong>&lt;br&gt; 2.1 Linear Regression Models&lt;br&gt; 2.2 Estimation of the Parameters in Linear Regression Models&lt;br&gt; 2.3 Hypothesis Testing in Multiple Regression&lt;br&gt; 2.4 Confidence Intervals in Multiple Regression&lt;br&gt; 2.5 Prediction of new response observation&lt;br&gt; 2.6 Regression model diagnostics&lt;br&gt; 2.7 Testing for lack of fit</td>
<td>08</td>
</tr>
<tr>
<td><strong>03</strong></td>
<td><strong>Two-Level Factorial Designs and Analysis</strong>&lt;br&gt; 3.1 The $2^2$ Design&lt;br&gt; 3.2 The $2^3$ Design&lt;br&gt; 3.3 The General $2^k$ Design&lt;br&gt; 3.4 A Single Replicate of the $2^k$ Design&lt;br&gt; 3.5 The Addition of Center Points to the $2^k$ Design,&lt;br&gt; 3.6 Blocking in the $2^k$ Factorial Design&lt;br&gt; 3.7 Split-Plot Designs</td>
<td>07</td>
</tr>
<tr>
<td><strong>04</strong></td>
<td><strong>Two-Level Fractional Factorial Designs and Analysis</strong>&lt;br&gt; 4.1 The One-Half Fraction of the $2^k$ Design&lt;br&gt; 4.2 The One-Quarter Fraction of the $2^k$ Design&lt;br&gt; 4.3 The General $2^{kp}$ Fractional Factorial Design&lt;br&gt; 4.4 Resolution III Designs&lt;br&gt; 4.5 Resolution IV and V Designs&lt;br&gt; 4.6 Fractional Factorial Split-Plot Designs</td>
<td>07</td>
</tr>
</tbody>
</table>
Conducting Tests
5.1 Testing Logistics
5.2 Statistical aspects of conducting tests
5.3 Characteristics of good and bad data sets
5.4 Example experiments
5.5 Attribute Vs Variable data sets

Taguchi Approach
6.1 Crossed Array Designs and Signal-to-Noise Ratios
6.2 Analysis Methods
6.3 Robust design examples

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REFERENCES:
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO 1015</td>
<td>Operations Research</td>
<td>03</td>
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</tbody>
</table>

**Objectives:**
1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

**Outcomes:** Learner will be able to…
1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model’s optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 01     | **Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research  
**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis  
**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem  
**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | 14 |
| 02     | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | 05 |
| 03     | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation | 05 |
| 04     | **Dynamic programming**: Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems. | 05 |
| 05     | **Game Theory**: Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. | 05 |
Assessment:

Internal:
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End Semester Theory Examination:
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</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Cybercrime:</strong> Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td><strong>Tools and Methods Used in Cyberline</strong> Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)</td>
<td>6</td>
</tr>
<tr>
<td>05</td>
<td><strong>Indian IT Act.</strong> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments</td>
<td>6</td>
</tr>
<tr>
<td>06</td>
<td><strong>Information Security Standard compliances</strong> SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.</td>
<td>6</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

**Outcomes:**
1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development
Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

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4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538
## Course: Disaster Management and Mitigation Measures

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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ILO 1017</td>
<td>Disaster Management and Mitigation Measures</td>
<td>03</td>
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</tbody>
</table>

### Objectives:
1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

### Outcomes: Learner will be able to…
1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do’s and don’ts in such extreme events and act accordingly.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.</td>
<td>03</td>
</tr>
<tr>
<td>02</td>
<td>Natural Disaster and Manmade disasters:</td>
<td></td>
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<tr>
<td></td>
<td>2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.</td>
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</tr>
<tr>
<td>03</td>
<td>Disaster Management, Policy and Administration</td>
<td></td>
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<tr>
<td></td>
<td>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.</td>
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<tr>
<td></td>
<td>3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td>Institutional Framework for Disaster Management in India:</td>
<td></td>
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<tr>
<td></td>
<td>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</td>
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<tr>
<td>05</td>
<td>Financing Relief Measures:</td>
<td></td>
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<tr>
<td></td>
<td>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO’s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO’s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>5.2 International relief aid agencies and their role in extreme events.</td>
<td></td>
</tr>
</tbody>
</table>
Preventive and Mitigation Measures:
6.1 Pre-disaster, during disaster and post-disaster measures in some events in general
6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication
6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.
6.4 Do’s and don’ts in case of disasters and effective implementation of relief aids.

Assessment:

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4. Only Four question need to be solved.

REFERENCES:
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)
ILO 1018 | Energy Audit and Management | 03

Objectives:
1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management.
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…
1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.
5. To analyze the data collected during performance evaluation and recommend energy saving measures.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Energy Scenario:</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td>Energy Audit Principles:</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring &amp; targeting: Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR).</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Energy Management and Energy Conservation in Electrical System:</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. <strong>Energy efficiency measures in lighting system, Lighting control:</strong> Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation-types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</td>
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<tr>
<td>05</td>
<td>Energy Performance Assessment:</td>
<td>04</td>
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<tr>
<td></td>
<td>On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Energy conservation in Buildings:</td>
<td>03</td>
</tr>
<tr>
<td></td>
<td>Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</td>
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REFERENCES:

1. Handbook of Electrical Installation Practice, Geoffry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
8. www.energymangertraining.com
9. www.bee-india.nic.in
Simulation study using mathematical simulation software (or any programming language) on any six

1. Create 3-D solid models of complex objects given a multi-view representation (minimum 2 to 3).

   Project: For a given system consisting of four to five components do as described below;
   1. Create solid models of individual parts
   2. Create reference geometry features (planes, axes)
   3. Create solid features using sweeping and lofting operations
   4. Measure properties of 3-D CAD models
   5. Create assemblies of CAD parts with appropriate mating relationships

Assessment:

Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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</thead>
<tbody>
<tr>
<td>PDDL102</td>
<td>Rapid Prototyping And Tooling Lab</td>
<td>01</td>
</tr>
</tbody>
</table>

Following activity can be demonstrated either in the Institute or visiting any organization where this type of work is done.

1. Study of reverse engineering concepts
2. Demonstration of 3D scanning
3. Study of rapid prototyping machines
4. Demonstration of Fusion Deposition Modeling
5. Demonstration of Selective Laser Sintering
6. Demonstration of Vacuum casting
7. Demonstration of Virtual Reality

Project: In a group of not more than 4 students

Identify an existing consumer product, develop CAD model, simulate in CAE environment, optimize, develop tooling and make a physical prototype. Prepare a detailed report.

**Assessment:**

Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
Course Code: PDDC201  
Course Name: Quality Concepts In Design  
Credits: 04

Objectives
1. To study importance of various principles of quality in a product or service through.
2. To study application of statistical tools in product development

Outcomes: Learner will be able to…
1. Understand concepts in quality and reliability principles in the design of an engineering product or a service.
2. Apply statistical techniques such as quality houses, control charts, statistical process control method, failure mode effect analysis in new product development process
3. Strategies of designing experiments, methods to uphold the status of six sigma and improve the reliability of a product.

<table>
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<tr>
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<tbody>
<tr>
<td>01</td>
<td>DESIGN FOR QUALITY</td>
<td></td>
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<tr>
<td></td>
<td>Quality Function Deployment - House of Quality- Objectives and functions- Targets- Stakeholders-Measures and Matrices- Design of Experiments – Bench marking.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>FAILURE MODE EFFECT ANALYSIS</td>
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<tr>
<td></td>
<td>Basic methods: Refining geometry and layout, general process of product embodiment- Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling- Case study computer monitor stand for a docking station.</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>DESIGN OF EXPERIMENTS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Design of experiments- Basic methods- Two factorial experiments- Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design- Statistical analysis of experiments: Degree of freedom, correlation coefficient, standard error of the residual t-test, ANOVA-ratio test, other indicators- residual plots, Advanced DOE method for product testing- Product applications of physical modeling and DOE, Blender panel display evaluation, coffee grinder experimental optimization- Taguchi method.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td>STATISTICAL CONSIDERATION IN PRODUCT DESIGN AND DEVELOPMENT</td>
<td></td>
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<tr>
<td></td>
<td>Frequency distributions and Histograms- Run charts – stem and leaf plots- Pareto diagrams- Cause and Effect diagrams- Box plots- Probability distribution- Statistical Process control– Scatter diagrams – Multivariable charts – Matrix plots and 3-D plots.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>RELIABILITY</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reliability- Survival and Failure- Series and parallel systems- Mean time between failure- Weibull distributions (How to calculate or estimate in component level system level introductory only)</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>DESIGN FOR SIX SIGMA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Basis of SIX SIGMA- Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production – Lean SIX SIGMA and services</td>
<td>08</td>
</tr>
</tbody>
</table>
Assessment:

Internal:
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End Semester Theory Examination:
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1. Question paper will comprise of total six question
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4. Only Four questions need to be solved.

References:

**Course Code**: PDDC202  
**Course Name**: Design For X  
**Credits**: 04

**Objectives**  
1. To study the concept of design for manufacturing, assembly and environment.  
2. To study the product development economics.

**Outcomes**: Learner will be able to…  
1. Apply design concepts for manufacturing, assembly and environment

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 01     | **DESIGN FOR MANUFACTURE**:  
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks | 05 |
| 02     | **DESIGN FOR ASSEMBLY**:  
Assembly processes-Handling and insertion process- Manual, automatic and robotic assembly- Cost of Assembly- Number of Parts- DFA guidelines | 10 |
| 03     | **VALUE ENGINEERING**:  
| 04     | **PRODUCT DEVELOPMENT ECONOMICS**:  
| 05     | **CONCEPT OF RELIABILITY**:  
Introduction: The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution: The reliability Function, Mean Time to Failure, Hazard Rate Function, Bath tub Curve, Conditional Reliability | 07 |
| 06     | **MAINTAINABILITY**:  
Analysis of down time, Report Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependant System with Repair, Design for Maintainability. | 07 |
Assessment:

Internal:
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4. Only Four questions need to be solved.

References:

Objectives
1. To expose the students to the various aspects of Industrial Design so as to develop new products considering aesthetics, ergonomics, environment and other human factors.

Outcomes: Learner will be able to…
1. Understand the importance of ergonomics in the design of new products
2. Learn the effect of biomechanics, biothermodynamics, bioenergetics on the design and development of new products.
3. Understand the effects of other human factors

Module | Detailed Contents | Hrs.
--- | --- | ---
02 | Human-Machine System: Cognition, Decision Making, Displays, Control | 8
03 | Human Performance in the Workplace: Anthropometry and Workplace Design, Biomechanics of Work, Work Physiology, Stress and Workload | 10
04 | Ergonomics - Physical design: User-technology physical interface design Who are the users? How does the technology fit different user dimensions? How does the technology fit user anatomy? How does the technology fit user strength? How does the technology accommodate different abilities? How safe is the technology (health, comfort, performance)? How do users interact with technology? | 8
05 | Introduction to the concept of system design and Ergonomics Ergonomics in product design, the interface design, Body dimensions and its application in design. Dimensional optimization for the population and use of percentile, The musculo-skeletal system and joint motion study, Human body following the principle of lever, biomechanical stresses on our body. Effect of stresses imposed on body. Design from the view point of biomechanics, Work posture analysis, Static and Dynamic work, the visual, auditory and thermal environment and their impact on design. Controls and display aspects of design. Research techniques in Ergonomic data generation, interpretation and application of statistical methods. | 8
06 | Introduction to basic elements of design and Ergonomics: Line, texture, colour, form, symmetry, balance, scale, mass, unity and variety. Concept of visual language and visual design. Introduction to Gestalt laws, composition and figure and ground relationships. Introduction to concept of negative space, Use of symmetry. Generation of patterns and textures using simple elements. | 8
Assessment:

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<th>Detailed Contents</th>
<th>Hrs.</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Automotive engineering development:</strong> Innovation and Inventions, Styling Development, Streamlining, Engine Developments, Transmission Developments, Steering, Brakes, Suspension, Wheels and Tyres, Interior Refinement, Safety Design</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Modern materials and their incorporation into vehicle design:</strong> Structure and manufacturing technology of automotive materials, Metals and Alloys, Plastics and Polymers, Ceramics and Glasses, Composite Materials, Mechanical and Physical Properties of Automotive Materials, Selection of Automotive Materials</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>Body design: The styling process:</strong> The Studios, working environment and structure, Product Planning, Concept sketching and Package related sketching, Full sized tape drawing, Clay Modelling, Use of 2D CAD system, Use of 3D CAD System, Rendering Techniques</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Body design: Aerodynamics:</strong> Aerodynamic forces, Drag, Drag reduction, Stability and cross winds, Noise, Ventilation, Wind tunnel testing, Use of CFD <strong>Basic Concepts in Design and Analysis:</strong> Chassis, Suspension systems, Braking systems, Transmission and driveline, Noise and Vibration</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Occupant accommodation: an ergonomics approach:</strong> Ergonomics in Automotive Industry, Ergonomic methods and tools to promote occupant accommodation, Standards, Guidelines and Recommendations, Anthropometry, Testing</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Future trends in automobile design:</strong> Mechanical possibilities, Advances in Manufacturing Methods, Materials advances, Energy conservation, Power systems, Electrical, Electronic and Hybrid possibilities, Vehicle information and navigation systems</td>
<td>08</td>
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</tbody>
</table>
Assessment:

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End Semester Theory Examination:
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References:

5. ISBN 0-07-059202-0
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDDDLO2022</td>
<td>Polymeric Materials And Processing</td>
<td>04</td>
</tr>
</tbody>
</table>

**Objectives**
1. To study the behavior of polymeric materials
2. To study the applicability of polymers for various industrial applications
3. To study the effect of polymeric materials on the environment and vice versa

**Outcomes:** Learner will be able to…
1. Select an appropriate polymeric material for a given application
2. Choose an appropriate process to fabricate a product from the polymeric material
3. Select an appropriate testing method to evaluate a given property of a polymeric material
4. Develop the methods to minimise the effect of polymeric materials on the environment and vice versa.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 01     | **Introduction**
Terminology of plastics, Early history of polymers, Development of plastic products, Designing a polymer structure for improved properties, Plastic properties - Mechanical Properties, Reinforced Properties, Electrical properties, Optical properties, Thermal Properties | 8    |
| 02     | **Polymer Characterization**
Solubility and swelling, concept of average molecular weight, determination of number average, weight average, viscosity average and Z-average molecular weights, polymer crystallinity, analysis of polymers using IR, XRD, thermal (DSC, DMTA, TGA), microscopic (optical and electronic) techniques. | 8    |
| 03     | **Industrial Polymers**
Polymers in special uses - High temperature and fire resistance, liquid crystal Polymers, electro active polymer, Polymer supported catalysts, Optical information storage. | 10   |
| 04     | **Fabrication Processes**
Types of processes, tooling for plastic processing, compression moulding, Transfer moulding, Injection moulding of thermoplastics, Injection moulding of thermosetting resins, Extrusion, Pultrusion, Blow Moulding, Calenading, Rotational moulding, Thermoforming, Casting process, Foaming Process, Reinforcing process | 10   |
| 05     | **Polymer Testing**
Mechanical - static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness.
Conductivity - thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, ageing resistance, environmental stress cracking resistance. | 10   |
| 06     | **Plastics and Environment**
Effect of plastics on the environment, effect of environmental factors on the behaviour of plastics in outdoor environment, behaviour of plastics in the biotic environment, behaviour of plastics in the fire environment | 6    |
Assessment:

Internal:
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed 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:

Objectives
1. To study Understand the Reverse Engineering (RE) Methodology.
2. To study patent and copy right issues.

Outcomes: Learner will be able to…
1. Understand of basic engineering systems.
2. Apply the terminologies related to re-engineering, forward engineering, and reverse engineering.
3. Understand Reverse Engineering methodologies.
4. Apply Reverse engineering in Mechanical Systems.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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</thead>
</table>
| 01     | **Introduction**  
| 02     | **Geometrical Form**  
| 03     | **Material Characteristics and Analysis**  
          Alloy Structure Equivalency, Phase Formation and Identification, Mechanical Strength, Hardness  
          **Part Durability and Life Limitation**  
          Part Failure Analysis, Fatigue, Creep and Stress Rupture, Environmentally Induced Failure | 10   |
| 04     | **Material Identification and Process Verification**  
          Material Specification, Composition Determination, Microstructure Analysis, Manufacturing Process Verification | 12   |
| 05     | **Data Process and Analysis**  
          Statistical Analysis, Data Analysis, Reliability and the Theory of Interference, Weibull Analysis, Data Conformity and Acceptance, Data Report  
          **Part Performance and System Compatibility**  
          Performance Criteria, Methodology of Performance Evaluation, System Compatibility | 08   |
| 06     | **Acceptance and Legality**  
          Legality of Reverse Engineering, Legal Definition of Reverse Engineering, Legal Precedents on Reverse Engineering, Patent, Copyrights, Copyright Codes, Legal Precedents on Copyrights, Trade Secret, Case Study of Reverse Engineering a Trade Secret, Third-Party Materials | 07   |
Assessment:

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4. Only Four questions need to be solved.

References:

Course Code | Course Name | Credits
---|---|---
PDDLO2024 | Product Marketing | 04

**Objectives**
1. To provide the student with an overview of marketing research techniques.
2. To impart fundamental knowledge of marketing research and its application in the front end of product development

**Outcomes:** Learner will be able to…
1. Choose appropriate marketing analysis tools.
2. Understand consumer behaviour and need for product development
3. Select pricing for products and services

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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</thead>
</table>
| 01 | **Advanced Marketing Planning**  
**Introduction:** Concept, nature, scope and importance of marketing; Marketing concept and its evolution; Marketing mix; Strategic marketing planning – an overview.  
**Market Analysis and Selection:** Marketing environment – macro and micro components and their impact on marketing decisions; Market segmentation and positioning; | 08 |
| 02 | **Consumer Behaviour**  
Introduction to Consumer Behaviour (CB): Nature and Importance of CB, application of CB in Marketing , Consumer Research process.  
Consumer Decision making Process:  
· Problem recognition  
· Information Search Process and Evaluation  
· Purchasing process  
· Post purchase behaviour | 08 |
| 03 | **Marketing Research**  
An overview of the Marketing Research Process, Research Designs, Exploratory Research, Descriptive Research, Experimental Research,  
Uncontrollable Variables:  
History, Maturation, Testing Effect, Measurement of Variation and Interactive Effect. Types of Data-Primary Data and Secondary Data, Secondary Data Sources for MR in India. | 08 |
| 04 | **Pricing Strategies**  
An Introduction to Pricing Basic Frameworks  
Overview of common pricing methods  
Psychology and Measurement  
The role of consumer psychology in pricing  
Price Discrimination  
Effective market segmentation  
New product pricing and building | 08 |
| 05 | **Brand Strategy**  
Concept of Brand, Significance of Branding for Consumers and for Firms, Branding Challenges and Opportunities, Concept of Brand Equity, Cost based, Price based and Customer based Brand Equity, Customer Based Brand Equity  
Sources of Brand Equity- Brand Awareness and Brand Image, Keller’s CBBE Model- Identity, Meaning, Response and Relationships.  
Brand Positioning  
Definition of Target Market & Market Segmentation, Defining the Competitive Frame of Reference, Establishing the Points of Parity & Points of difference. |
| 06 | **Designing the Supply Chain network**  
Understanding the supply Chain, Designing the distribution network, Designing and Planning Transportation Network |

**Assessment:**

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**References:**

2. Loudan, David L and Bitta, A.J. Della Consumer Behaviour  
3. Schiffman LG and Kanuk LL Consumer Behaviour  
4. Nair, Suja R, Consumer Behaviour in Indian  
5. Marketing Research: Text & Cases, Boyd, Westfall & Stasch, R D Irwin  
6. Research For Marketing Decisions, Green & Tull, Prentice Hall  
7. Thomas T. Nagle, the Strategy and Tactics of Pricing, Prentice Hall  
8. Pricing a Portfolio of Products complements & substitutes new product pricing  
9. Strategic Brand Management, Keller, Parmeswaran & Jacob, Pearson  
11. Supply Chain Management Strategy, Planning and Operationby Sunil Chopra, Pearson Education.
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>
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</table>
| 01     | Project Management Foundation:  
Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & 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). | 5 |
| 02     | Initiating Projects:  
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 & growth (forming, storming, norming & performing), team dynamics. | 6 |
| 03     | Project Planning and Scheduling:  
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). | 8 |
| 04     | Planning Projects:  
| 05     | 5.1 Executing Projects:  
Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.  
5.2 Monitoring and Controlling Projects:  
Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.  
5.3 Project Contracting  
Project procurement management, contracting and outsourcing. | 8 |
| 06     | 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. | 6 |
Assessment:
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   3. Questions will be mixed in nature (for example supposed 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. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
4. Gopalan, Project Management, , 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>
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</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>
<tr>
<td>06</td>
<td>Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity’s Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon’s Approach, Walter’s Approach, and Modigliani-Miller Approach</td>
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References:
# Entrepreneurship Development and Management

- **Course Code:** ILO2023
- **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>01</td>
<td><strong>Overview Of Entrepreneurship:</strong> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td><strong>Business Plans And Importance Of Capital To Entrepreneurship:</strong> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur <strong>Entrepreneurship And Business Development:</strong> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations</td>
<td>09</td>
</tr>
<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><strong>Indian Environment for Entrepreneurship:</strong> 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><strong>Effective Management of Business:</strong> 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><strong>Achieving Success In The Small Business:</strong> 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:
Internal:
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End Semester Theory Examination:
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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed 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. 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
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 behavioral 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 behavioral 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>
</table>
| 01     | Introduction to HR  
            • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.  
            • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 5 |
| 02     | Organizational Behavior (OB)  
            • Introduction to OB Origin, Nature and Scope of Organizational Behavior, 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 Behavior.  
            • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);  
            • Group Behavior 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 | 7 |
| 03     | Organizational Structure & Design  
            • 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. | 6 |
| 04     | Human resource Planning  
            • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.  
            • Training & Development: Identification of Training Needs, Training Methods | 5 |
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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<tbody>
<tr>
<td>01</td>
<td><strong>Professional Ethics and Business</strong>: 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>
</tbody>
</table>
| 02     | **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 | 08  |
| 03     | **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. | 06  |
| 04     | **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 | 05  |
| 05     | **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 | 08  |
| 06     | **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. | 08  |

**Assessment:**

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References:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
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<tbody>
<tr>
<td>01</td>
<td><strong>Introduction and Basic Research Concepts</strong></td>
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<tr>
<td></td>
<td>1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</td>
<td>09</td>
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<tr>
<td></td>
<td>1.2 Need of Research in Business and Social Sciences</td>
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<td>1.3 Objectives of Research</td>
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<td></td>
<td>1.4 Issues and Problems in Research</td>
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<td>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</td>
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<tr>
<td>02</td>
<td><strong>Types of Research</strong></td>
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<td></td>
<td>2.1. Basic Research</td>
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<td>2.2. Applied Research</td>
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<td>2.3. Descriptive Research</td>
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<td>2.4. Analytical Research</td>
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<td>2.5. Empirical Research</td>
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<td></td>
<td>2.6 Qualitative and Quantitative Approaches</td>
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<td>03</td>
<td><strong>Research Design and Sample Design</strong></td>
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<tr>
<td></td>
<td>3.1 Research Design – Meaning, Types and Significance</td>
<td>07</td>
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<td></td>
<td>3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design</td>
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<td>3.3 Sampling methods/techniques Sampling Errors</td>
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<td>04</td>
<td><strong>Research Methodology</strong></td>
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<td></td>
<td>4.1 Meaning of Research Methodology</td>
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<td>4.2. Stages in Scientific Research Process:</td>
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<tr>
<td></td>
<td>a. Identification and Selection of Research Problem</td>
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<td>b. Formulation of Research Problem</td>
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<td>c. Review of Literature</td>
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<td>d. Formulation of Hypothesis</td>
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<td>e. Formulation of research Design</td>
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<td>f. Sample Design</td>
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<td>g. Data Collection</td>
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<td>h. Data Analysis</td>
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<td></td>
<td>i. Hypothesis testing and Interpretation of Data</td>
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<td>j. Preparation of Research Report</td>
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<td>05</td>
<td><strong>Formulating Research Problem</strong></td>
<td>04</td>
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<tr>
<td></td>
<td>5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</td>
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<tr>
<td>06</td>
<td><strong>Outcome of Research</strong></td>
<td>04</td>
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<td></td>
<td>6.1 Preparation of the report on conclusion reached</td>
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<td></td>
<td>6.2 Validity Testing &amp; Ethical Issues</td>
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<td></td>
<td>6.3 Suggestions and Recommendation</td>
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4. Only Four questions need to be solved.

References:
**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>
<thead>
<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</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>02</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>03</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>04</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>05</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>
<td>08</td>
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<th>Hours</th>
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</thead>
</table>
| 1      | **Introduction to Digital Business** - Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts  
**Drivers of digital business** - Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)  
Opportunities and Challenges in Digital Business, | 09 |
| 2      | **Overview of E-Commerce**  
**E-Commerce** - Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement  
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 | 06 |
| 3      | **Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system  
**Application Development**: Building Digital business Applications and Infrastructure | 06 |
| 4      | **Managing E-Business** - Managing Knowledge, Management skills for e-business, Managing Risks in e –business  
| 5      | **E-Business Strategy** - E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy,  
E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | 04 |
| 6      | **Materializing e-business: From Idea to Realization** - Business plan preparation  
Case Studies and presentations | 08 |
Assessment:

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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
Objective:
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

<table>
<thead>
<tr>
<th>Module</th>
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</tr>
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<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/Madem 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 &amp; 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>
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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
Introduction to surface modelling
1. Coordinate transformations (translation, rotation, scaling, reflection)
2. Working with drawings, views, dimensions and tolerances.
3. Sheet metal design
4. Surface Modelling

**Project:**
1. Create CAD models of any two given objects involving above features, such as car side mirror body, mouse body, bottles etc.

**Assessment:**

Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>PDDL202</td>
<td>Computer Aided Engineering Lab</td>
<td>01</td>
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</table>

**Introduction to computer aided engineering**

1. Modelling of an element/system
2. Finite Element Analysis of an element/system (Involves element selection, assigning properties, meshing, assigning loads and boundary conditions, analysis and result interpretation)
3. Optimization of an element/system (minimization of mass) through FEA.

**Project:** Select any engineering element/system and optimize the design through FEA approach

**Assessment:**

Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
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<th>Credits</th>
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<tbody>
<tr>
<td>PDDS301</td>
<td>Seminar</td>
<td>03</td>
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</table>

**Guidelines for Seminar**

- Seminar should be based on thrust areas in Mechanical Engineering (Product Design and Development aspect is appreciated)
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format as per University Guidelines for report writing and present in front of pair of Examiners appointed by the Head of the Department/Institute of respective Programme.
- **Seminar should be assessed jointly by the pair of Internal and External Examiners**
  - Seminar should be assessed based on following points
    - Quality of Literature survey and Novelty in the topic
    - Relevance to the specialization
    - Understanding of the topic
    - Quality of Written and Oral Presentation
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<th>Credits</th>
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<tbody>
<tr>
<td>PD/DD301/PDD/401</td>
<td>Dissertation (I and II)</td>
<td>12 + 15</td>
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</table>

**Guidelines for Dissertation**
- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

**Guidelines for Assessment of Dissertation I**
- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of internal examiners appointed by the Head of the Department/Institute of respective Programme.

**Guidelines for Assessment of Dissertation II**
- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai

Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)

**Dissertation Report has to be prepared strictly as per University of Mumbai report writing guidelines.**