UNIVERSITYOFMUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

CAD CAM and Robotics

(As per Choice Based Credit 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 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 brainstorming 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 stakeholders.

Dr. S. M. Khot

Chairman, Board of Studies in Mechanical Engineering, University of Mumbai
# Program Structure for
# ME Mechanical Engineering (CAD/CAM and Robotics)
# Mumbai University
# (With Effect from 2016-2017)

## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract</td>
</tr>
<tr>
<td>CCC101</td>
<td>Computer Aided Design</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>CCC102</td>
<td>Control Engineering</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>CCC103</td>
<td>Mechatronics</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>CCDLO101X</td>
<td>Department Level Optional Course I</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>ILO101X</td>
<td>Institute Level Optional Course I</td>
<td>03</td>
<td>--</td>
</tr>
<tr>
<td>CCL101</td>
<td>Laboratory I - CAD and Computer Aided Engineering</td>
<td>--</td>
<td>02</td>
</tr>
<tr>
<td>CCL102</td>
<td>Laboratory II - Mechatronics and Robotics</td>
<td>--</td>
<td>02</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>19</td>
<td>04</td>
</tr>
</tbody>
</table>

## Examination Scheme

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Avg</th>
<th>End Sem Exam</th>
<th>Exa m Dura tion (Hrs)</th>
<th>Term Work</th>
<th>Pract /Oral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC101</td>
<td>Computer Aided Design</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>03</td>
<td>--</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>CCC102</td>
<td>Control Engineering</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>03</td>
<td>--</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>CCC103</td>
<td>Mechatronics</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>03</td>
<td>--</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>CCDLO101X</td>
<td>Department Level Optional Course I</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>03</td>
<td>--</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>ILO101X</td>
<td>Institute Level Optional Course I</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>80</td>
<td>03</td>
<td>--</td>
<td>--</td>
<td>100</td>
</tr>
<tr>
<td>CCL101</td>
<td>Laboratory I - CAD and Computer Aided Engineering</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>CCL102</td>
<td>Laboratory II - Mechatronics and Robotics</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>400</td>
<td>50</td>
<td>50</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Department Level Optional Course I</td>
<td>Course Code</td>
<td>Institute Level Optional Course I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------</td>
<td>-------------</td>
<td>---------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCDLO1011</td>
<td>Product Design</td>
<td>ILO1011</td>
<td>Product Lifecycle Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCDLO1012</td>
<td>Simulation and Modeling</td>
<td>ILO1012</td>
<td>Reliability Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCDLO1013</td>
<td>Artificial Intelligence and Expert Systems</td>
<td>ILO1013</td>
<td>Management Information System</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCDLO1014</td>
<td>Advanced Finite Element Analysis</td>
<td>ILO1014</td>
<td>Design of Experiments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1015</td>
<td>Operation Research</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1016</td>
<td>Cyber Security and Laws</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1017</td>
<td>Disaster Management and Mitigation Measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO1018</td>
<td>Energy Audit and Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Name</td>
<td>Teaching Scheme (Contact Hours)</td>
<td>Credits Assigned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------------------------</td>
<td>---------------------------------</td>
<td>------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCC201</td>
<td>Robotics</td>
<td>04 -- 04</td>
<td>04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCC202</td>
<td>Advanced Manufacturing Technology</td>
<td>04 -- 04</td>
<td>04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCC203</td>
<td>Computer Aided Machining (CAM)</td>
<td>04 -- 04</td>
<td>04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCDLO 202X</td>
<td>Department Level Optional Course II</td>
<td>04 -- 04</td>
<td>04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ILO202X</td>
<td>Institute Level Optional Course II</td>
<td>03 -- 03</td>
<td>03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCL201</td>
<td>Laboratory III –CAM</td>
<td>-- 02 01</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CCL202</td>
<td>Laboratory IV -Rapid Manufacturing</td>
<td>-- 02 01</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>19 04 19</td>
<td>02 21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCC201</td>
<td>Robotics</td>
<td>20 20 20 80 03 -- -- 100</td>
</tr>
<tr>
<td>CCC202</td>
<td>Advanced Manufacturing Technology</td>
<td>20 20 20 80 03 -- -- 100</td>
</tr>
<tr>
<td>CCC203</td>
<td>Computer Aided Machining (CAM)</td>
<td>20 20 20 80 03 -- -- 100</td>
</tr>
<tr>
<td>CCDLO 202X</td>
<td>Department Level Optional Course II</td>
<td>20 20 20 80 03 -- -- 100</td>
</tr>
<tr>
<td>ILO202X</td>
<td>Institute Level Optional Course II</td>
<td>20 20 20 80 03 -- -- 100</td>
</tr>
<tr>
<td>CCL201</td>
<td>Laboratory III –CAM</td>
<td>-- -- -- 25 25 50</td>
</tr>
<tr>
<td>CCL202</td>
<td>Laboratory IV -Rapid Manufacturing</td>
<td>-- -- -- 25 25 50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>100 100 100 400 50 50 600</td>
</tr>
<tr>
<td>Course Code</td>
<td>Department Level Optional Course II</td>
<td>Course Code</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>CCDLO2021</td>
<td>Smart Materials</td>
<td>ILO2021</td>
</tr>
<tr>
<td>CCDLO2022</td>
<td>Rapid Manufacturing</td>
<td>ILO2022</td>
</tr>
<tr>
<td>CCDLO2023</td>
<td>MEMS</td>
<td>ILO2023</td>
</tr>
<tr>
<td>CCDLO2024</td>
<td>Optimization</td>
<td>ILO2024</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2025</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2026</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2027</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2028</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ILO2029</td>
</tr>
</tbody>
</table>
### Semester III

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS301</td>
<td>Seminar</td>
<td>-- 06 -- 03</td>
<td>03</td>
</tr>
<tr>
<td>CCD302</td>
<td>Dissertation I</td>
<td>-- 24 -- 12</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>-- 30 --</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1</td>
</tr>
<tr>
<td>CCS301</td>
<td>Seminar</td>
<td>--</td>
</tr>
<tr>
<td>CCD301</td>
<td>Dissertation I</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>--</td>
</tr>
</tbody>
</table>

### Semester IV

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCD401</td>
<td>Dissertation II</td>
<td>-- 30 --</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>-- 30 --</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test1</td>
</tr>
<tr>
<td>CCD401</td>
<td>Dissertation II*</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>--</td>
</tr>
</tbody>
</table>

*Seminar 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
### Course Prerequisites:
1. Linear Algebra – Basics of Matrix Multiplication and Coordinate Geometry
2. Good programming skills

### Objectives:
1. Learn the rudiments of Computer Aided Design (CAD) and CAD systems.
2. Use 3D modeling software to accurately generate and easily modify graphical representations of the product.
3. Enable the use of efficient product data management techniques.
4. Enable the use of programming languages to program various algorithms for problem solving—related to generation of computer graphics and application to engineering design process.

**Outcomes:** Upon completion of the course, learner should be able to—

1. Integrate the role of graphic communication in the engineering design process.
2. Use algorithmic foundation for solving problems by writing computer programs.
3. Implement 2D and 3D transformations for positioning/shaping objects, or to change viewing positions, or even to change how something is viewed (e.g. perspective projections).
4. Formulate the parametric representation of standard conic shapes, 2D and 3D freeform curves and surfaces in the most efficient manner—required for creating complex profiles and geometries.
5. Describe various techniques of computer simulated reality i.e. virtual realism.

### Module | Detailed content | Hours
--- | --- | ---
1 | Introduction to Computer Graphics: Definitions, Classification, Architecture of Interactive Computer Graphics, Applications Display &Interactive devices Scan Conversion: 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 | 8
2 | Object Transformations: 2D & 3D (Translation, Rotation, Reflection, Scaling, Shearing); Homogeneous Coordinates, Decomposition of combined transformation matrix into basic transformation matrices (limited to three) taken in order | 8
3 | 2-D Viewing & Clipping, 3D Viewing & Clipping Projections: Parallel &Perspective Projections | 8
4 | Curves: Spline curve, Bezier curve, DeCasteljau Algorithm for generating Bezier curves (limited to cubic curves), B-Spline curve, NURBS curve Surfaces: Hermite, Bezier & B-Spline surfaces | 8
5 | Virtual Reality: Hidden Lines &Hidden Surfaces: Z-Buffer, Painters, Area-Subdivision, Scan Line algorithm Light, Color &Shading Models, Animation | 8

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:
2. Computer Graphics—Zhigang Xiang & Roy Plastock (Schaum’s Outlines)
5. Procedural Elements for Computer Graphics—David F. Rogers, James Alan Adams
6. Mastering CAD/CAM—Ibrahim Zeid
7. Geometric Modelling—Mortenson, M.E.
10. CAD/CAM - Theory and Practice—Ibrahim Zeid, R Sivasubramanian
12. CAD CAM - Principles, Practice, and Manufacturing Management—Chris McMahon, Jimmie Browne
13. Curves and Surfaces in Computer Aided Geometric Design—Fujio Yamaguchi
15. Computer Aided Engineering Design—AnupamSaxena, Birendra Sahay
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to control systems. Classification of control system, Effect of feedback. Mathematical modeling of control systems (mechanical, electrical systems), concept of transfer function. Block diagram algebra, and signal flow graphs.</td>
</tr>
<tr>
<td>03</td>
<td>Classification of control systems according to 'TYPE' of systems, Stability analysis: Introduction to concepts of stability. The Routh and Hurwitz stability criteria. Relative stability analysis.</td>
</tr>
<tr>
<td>04</td>
<td>Root locus Techniques. Frequency Response Analysis, Frequency domain specifications Correlation between time and frequency response. Polar Plots. Bode Plots, Nyquist Plots,</td>
</tr>
<tr>
<td>05</td>
<td>State space modeling: Concept of state, state variable, state model. State space representation using physical and phase variables, decomposition of transfer function, diagonalisation. State transition matrix. Transfer function from state model. Controllability and observability of linear system.</td>
</tr>
<tr>
<td>06</td>
<td>Compensation (Introduction only): Types of compensator, selection of compensator, Lead, Lag and Lag-Lead compensation. Control system Components: servomotor, stepper motors, Synchros, Potentiometer, amplifiers</td>
</tr>
</tbody>
</table>
**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:**
5. Nise, control system Engineering, John wiley & sons, 3rd edition
Course Code | Course Name | Credits
--- | --- | ---
CCC103 | Mechatronics | 04

Objectives:

1. Synergize the mechanisms of physical devices with Electronics, Electrical and Information systems to problems and challenges in the areas of mechatronics,
2. Acquire knowledge of mechatronics in the field of product design, development and manufacturing

Outcomes: Learner will be able to,

1. Demonstrate knowledge of pneumatic, hydraulic, electrical circuits and combinations with logic design,
2. Understand mechatronics components and systems for a given application
3. Simulate mechatronics problems by simulation softwares
4. Demonstrate team-oriented skills within the field of mechatronics

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Mechatronics</strong> - Traditional and Mechatronics design, Mechatronics Key elements, Basic Components of Mechatronics Systems, Integrated design issues in Mechatronics, Mechatronics Design process, Mechatronics System in Factory, Home and Business Applications, Objectives, Advantages and Disadvantages of Mechatronics.</td>
<td>3</td>
</tr>
<tr>
<td>03</td>
<td><strong>Interfacing hardware with real world</strong> - Analog Interface and Data acquisition, Digital I/O interfacing, special function interfacing, signal conditioning, special utility support hardware Interfacing of: HEX-keyboards, LCD display, ADC, DAC and stepper motor with 8051 Micro controller.</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td><strong>Development of circuits for Industrial automation</strong> by Pneumatic systems, Electro-Pneumatic systems, Hydraulic systems, Electro - Hydraulic systems. <strong>Logic Gates</strong> - AND, OR, NOT, NAND and NOR, applications of basic control circuits based on these gates, Karnaugh map for signal simplification. <strong>PLC</strong> - Overview and applications of Programmable Logic Controllers in Manufacturing, Relay logic, programming a PLC using ladder diagram programming, Ladder logic programme for control of single cylinder and two cylinder pneumatic systems and hydraulic systems.</td>
<td>15</td>
</tr>
</tbody>
</table>

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.

Reference Books:
3. Process control & Instrumentation technology : Cirtis D Johnson
4. Industrial control & instrumentation W Bolaton, ( Orient Longman)
6. Mechatronics. HMT
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCDLO1011</td>
<td>Product Design</td>
<td>04</td>
</tr>
</tbody>
</table>

**Objectives**
1. To understand fundamental product design concepts
2. To understand product design methodologies
3. To understand product design needs and issues in industry

**Outcomes:** Learner will be able to……
1. Design the products as per the customer/industry requirements
2. Apply creatively new technologies and sciences in the design of solutions that are usable and functional for various applications.
3. Recognize the problems of conception and creation of products and systems which are appropriate with regards to the form, content, functionality and the value for human use and action.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Importance of product design, type of design, product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, Concept generation and evaluation methods, product architecture, Product life cycle Management with case studies, Creativity and Idea generation technique, importance of Quality Dimensions: Performance, Features, aesthetics, Ergonomics, Reliability, Sustainability, Serviceability, Brand value, Value Vs cost, Importance of shape, color, feature &amp; Resemblance.</td>
<td>08</td>
</tr>
<tr>
<td>3</td>
<td>Design for Manufacturing (DFM) and Design for Assembly (DFA) Designs for Maintainability, Designs for Environment, Design for Robustness: Taguchi Designs &amp; Design of Experiments (DOE).</td>
<td>08</td>
</tr>
<tr>
<td>4</td>
<td>Benchmarking, Supplier involvement robust design, QFD, Design &amp; process FMEA. Value Engineering / Value Analysis. : definition, methodology- FAST, Reverse Engineering, Concurrent engineering &amp; Sequential engineering</td>
<td>08</td>
</tr>
</tbody>
</table>


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:
1. Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI.
5. Product Design by Kevin Otto & Kristin Wood
Objectives
1. The primary objective of this course is to provide an insight into how simulation modeling can aid in effective decision-making.
2. It provides students with the basic system concept and definitions of system techniques to model and to simulate various systems, the ability to analyze a system and to make use of the information to improve the performance.

Outcomes: Learner will be able to,

1. Understand the system concept and apply functional modeling method to model the activities of a static system;
2. Simulate the operation of a system and make improvement according to the simulation results.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Principle of computer modelling and simulation: Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications. Components of a system - discrete and continuous systems, Models of a system -a variety of modeling Approaches.</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Discrete Event Formalisms Concepts of discrete event simulation, model components, a discrete event system simulation, simulation world views or formalisms. Characteristics of queueing systems, queueing notations, long run measures of performance of queueing systems, Steady state behavior of Markovian models (M/G/1, M/M/1, M/M/c) overview of finite capacity and finite calling population models, Network of Queues simulation of single channel queue, multi channel queue, inventory system and dump truck problem using event scheduling approach.</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Statistical Models in Simulation Overview of probability and statistics, useful statistical model, discrete distribution, continuous distribution, empirical distribution and Poisson process. Discrete uniform -distribution poisson distribution -geometric distribution - acceptance -rejection technique for Poisson distribution gamma distribution.</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>RANDOM NUMBER GENERATION: Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method -Linear congruential method -Tests for random numbers -The Kolmogorov-Smirnov test -the Chi-square test.. RANDOM VARIABLE GENERATION: Inversion transforms technique-exponential distribution. uniform distribution, weibull distribution, continuous distribution, generating approximate normal variates-Erlang distribution.</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Input Modeling Introduction, steps to build a useful model of input data, data collection, identifying the distribution with data, parameter estimation, suggested estimators, goodness of fit tests, selection input model without data, covariance and correlation, multivariate and time series input models.</td>
<td>10</td>
</tr>
</tbody>
</table>
6 Verification and Validation of Simulation Model
Introduction, model building, verification of simulation models, calibration and validation of models:- validation process, face validity, validation of model, validating input-output transformation, t-test, power of test, input output validation using historical data and Turing test.

Output Analysis
Types of simulations with respect to output analysis, stochastic nature of output data, measure of performance and their estimation, output analysis of terminating simulators, output analysis for steady state simulation.
variance reduction techniques -antithetic variables, variables verification and validation of simulation models.

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:
5. Frank L. Severance, “System Modeling and Simulation”
Objectives:
1. To Understand and explain the basic knowledge representation, problem solving, and learning methods of Artificial Intelligence and expert system.
2. To Assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular engineering problems.
3. To equip students with the tools to tackle new AI paradigm, develop an interest in the field sufficient to take more advanced subjects.
4. To develop intelligent systems by assembling solutions to concrete computational problems.

Outcomes: Learner will be able to…
1. Understand knowledge base, search methods, heuristic and state space methods etc.,
2. Understand/Simulate/imitate an intelligent human being, in terms of conversation.
3. Understand artificial intelligence, problem solving, intelligent agents, expert systems, search techniques.
4. Develop a piece of software which is able to process natural language, knowledge representation.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>AI and Internal Representation:</strong> Introduction, definitions-Turing approach, Cognitive modeling approach, Laws of thought approach, The rational agent approach, Foundations of AI (history). <strong>Intelligent Agents:</strong> Concept of Rational Agent, Structure of Intelligent agents, agent program, Examples. Simple reflex agent, Goal based agent, Utility based agent, Agent Environments, environment programs, Examples. <strong>Problem Solving</strong> : Solving problems by searching, Problem Formulation, Search Strategies, Uninformed Search Techniques, DFS, BFS, Uniform cost search, Iterative Deepening, Comparing different Techniques, Informed search methods – Best First Search, heuristic functions, Hill-Climbing, A*,IDA*. Crypt Arithmetic.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Game playing:</strong> Perfect decisions in two person games, Imperfect decisions, Alpha-beta pruning, Games with element of chance. <strong>Knowledge based agent</strong>, WUMPUS simple environmental class game, knowledge representations, reasoning and logic, prepositional logic, Agent for WUMPUS, translating knowledge into action, problems with prepositional agent. First order logics, (syntax and semantics), logical agent for WUMPUS, simple reflex agent, Representing change in the world, situation calculus, frame problems and relatives. Basic representations for planning, situation state and plan, representation for plans, practical planning.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Fundamentals Concepts and Models of Artificial Neural Systems:</strong> Biological Neuron and their Artificial Models, Models of ANN, Learning and Adaptation, Neural Networking Learning Rules. Single-layer Perception Classifiers. <strong>Multilayer Feed forward Networks:</strong> Linearly Non-separable Pattern Classification, Delta Learning Rule, Feed forward Recall and Error Back-Propagation Training, Learning Factor.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Uncertainty:</strong> uncertainty, representation of knowledge in uncertain domain, semantics of belief network, Representing ignorance-Dempster-shafer theory. <strong>Representing vagueness:</strong> Fuzzy sets and fuzzy logics, Fuzzy Relations, Fuzzy Function, Fuzzy Measures, Probabilities &amp; possibilities. Fuzzy Modeling and applications of Fuzzy Control, Neural and fuzzy machine Intelligence. Representing decision problems, Using decision networks, making simple decision and complex decision.</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Genetic Algorithm:</strong> Simple genetic algorithm, Simulation by hands, similarity templates (Schemata), Mathematical foundations, Schema Processing at work. The two-armed and k-armed Bandit Problem, The building block hypothesis, The minimal Deceptive Problem. Computer implementation of Genetic algorithm, Data Structures, Reproduction, Cross over and Mutation. Time to reproduce and time to Cross Mapping, Objective function to fitness, form, Fitness scaling. Applications of genetic algorithm, De-Jong and Function Optimization, Improvement in basic techniques. Introduction to Genetics based machine Learning its applications.</td>
<td>08</td>
</tr>
</tbody>
</table>

**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:**
2. Introduction to Artificial intelligence By Eugene Charniak, Drew McDermott AddisonWesley Artificial Neural Networks- B. Yegnanarayana, PHI, 1999.
4. Data Mining by Pieter Adriaans and Dolt Zantinge - Pearson Education Asia
5. Data Warehousing in the Real World by Sam Anahory and Dennis Murray.
9. Introduction to Data Mining & Knowledge Discovery – Edelstein, Herbert A.
Objectives:
1. To develop proficiency in finite element method after understanding the fundamental principles of FEM to solve realistic engineering problems in the field of thermal engineering, structural engineering, vibration analysis, fluid flow, etc.

Outcomes: Learner will be able to…
1. Generate the governing Finite element equations for systems governed by partial differential equations
2. Solve problems related trusses, heat transfer, free vibrations and fluid flow problems
3. Solve time dependent and / or non-linear problems
4. Use commercial software package to perform structural analysis, heat transfer modeling, fluid flow modeling and interpret the results.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to FEA, General FEM procedure,</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>• Approximate solutions of differential equations: FDM method, W-R technique,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• collocation least square sub-domain and Galerkin method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Numerical integration, Gauss quadrature in 2-D and 3-D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Structure of FEA program, Pre and Post processor, commercially available standard packages, and desirable features of FEA packages.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Principal of minimum total potential, elements of variational calculus, minimization of functional, Rayleigh-Ritz method, Formulation of elemental matrix equation, and assembly concepts.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>One Dimensional FEM:</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>• Coordinate system: Global, local, natural coordinate system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Shape functions: Polynomial shape functions, Derivation of shape functions, Natural co-ordinate and coordinate transformation, Linear quadratic and cubic elements, Shape functions using Lagrange polynomials. Convergence and compatibility requirement of shape functions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• One dimensional field problems: structural analysis (step-bar, taper-bar). Structural analysis with temperature effect, Thermal analysis, heat transfer from composite bar, fins. Fluid network and flow through porous medium, analysis of electrical network problems by FEA</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>• Trusses, Thermal effects in truss members, Beams.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Two dimensional finite elements formulations, Threenoded triangular element, Four-noded rectangular element, Four-noded quadrilateral element, derivation of shape functions: natural coordinates, triangular elements, and quadrilateral elements.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Six-noded triangular elements, Eight-noded quadrilateral elements, Nine-noded quadrilateral element; Strain displacement matrix for CST element</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>• Penalty Method, Lagrange methods, Multipoint Constraints</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Concept of Master/Slave entities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Examples of Contact problems.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Iso-parametric concepts, basic theorem, Iso-parametric, super-parametric, sub-parametric elements, Concept of Jacobian</td>
<td></td>
</tr>
</tbody>
</table>
5 | • Finite element formulation of Dynamics, application to free-vibration problems, Lump and consistent mass matrices, Eigen value problems.  
• Transient dynamic problems in heat transfer and solid mechanics.  
• Introduction to time-integration methods: Implicit and Explicit methods, Convergence, Impact of Mesh quality on convergence  
06

6 | • Three dimensional elements: Tetrahedron, Rectangular prism (brick), Arbitrary hexahedron; Three Dimensional polynomial shape functions, Natural co-ordinates in 3D, Three dimensional Truss(space trusses)  
• Introduction to material models: Introduction to plasticity (Von-Mises Plasticity), Hyper –elasticity. Generating and using experimental data to model material behaviour.  
• Errors in FEA, sources of errors, method of elimination, Patch test.  
08

**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:**

6. Desai and Abel, “Introduction to Finite Elements Methods”, CBS Publication  
8. Erik Thompson, “Introduction to Finite Element Methods”, Wiley India  
10. R.D.Cook, “Concepts & Applications of Finite Element Analysis”  
### Course Code | Course Name | Credits
---|---|---
ILO 1011 | Product Life Cycle Management | 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:** Learner will be able to…
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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Product Lifecycle Management (PLM):</strong> Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance &amp; Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications <strong>PLM Strategies:</strong> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>Product Data Management (PDM):</strong> 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</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td><strong>Virtual Product Development Tools:</strong> 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</td>
<td>05</td>
</tr>
</tbody>
</table>
**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:**
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 question need to be solved.

**REFERENCES:**

Course Code | Course Name | Credits
--- | --- | ---
ILO 1012 | Reliability Engineering | 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>
</tr>
</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:
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 question need to be solved.

REFERENCES:
Objective:
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:

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:
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 question need to be solved.
REFERENCES:
1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Strategy of Experimentation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Typical Applications of Experimental Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 Guidelines for Designing Experiments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.4 Response Surface Methodology</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td><strong>Fitting Regression Models</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 Linear Regression Models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Estimation of the Parameters in Linear Regression Models</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 Hypothesis Testing in Multiple Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.4 Confidence Intervals in Multiple Regression</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.5 Prediction of new response observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.6 Regression model diagnostics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.7 Testing for lack of fit</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td><strong>Two-Level Factorial Designs and Analysis</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1 The 2^2 Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2 The 2^3 Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3 The General2^k Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.4 A Single Replicate of the 2^k Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.5 The Addition of Center Points to the 2^k Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.6 Blocking in the 2^k Factorial Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7 Split-Plot Designs</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td><strong>Two-Level Fractional Factorial Designs and Analysis</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 The One-Half Fraction of the 2^k Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.2 The One-Quarter Fraction of the 2^k Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.3 The General 2^k-p Fractional Factorial Design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.4 Resolution III Designs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.5 Resolution IV and V Designs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.6 Fractional Factorial Split-Plot Designs</td>
<td></td>
</tr>
</tbody>
</table>

**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
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:
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 question need to be solved.

REFERENCES:
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss
Course Code | Course Name | Credits
--- | --- | ---
ILO 1015 | Operations Research | 03

**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:
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:
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 question need to be solved.

REFERENCES:

Course  Code  Course Name  Credits
ILO 1016  Cyber Security and Laws  03

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

Outcomes: Learner will be able to…
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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Cybercrime: 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>Tools and Methods Used in Cyberline 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>06</td>
<td>Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.</td>
<td>6</td>
</tr>
</tbody>
</table>
**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:**
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 question need to be solved.

**REFERENCES:**
1. Nina Godbole, SunitBelapure, *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
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
### 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>03</td>
</tr>
<tr>
<td></td>
<td>1.1 Definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of Disaster,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>hazard, global</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and Indian</td>
<td></td>
</tr>
<tr>
<td></td>
<td>scenario, general</td>
<td></td>
</tr>
<tr>
<td></td>
<td>perspective,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>importance of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>study in human</td>
<td></td>
</tr>
<tr>
<td></td>
<td>life, Direct and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>indirect effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of disasters,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>long term</td>
<td></td>
</tr>
<tr>
<td></td>
<td>effects of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disasters.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>global warming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and climate</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Natural Disaster</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>and Manmade</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disasters:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 Natural</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disaster: Meaning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and nature of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>natural disaster,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flood, Flash</td>
<td></td>
</tr>
<tr>
<td></td>
<td>flood, drought,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cloud burst,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Earthquake,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Landslides,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avalanches,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Volcanic eruptions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mudflow, Cyclone,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storm, Storm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surge, climate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>change, global</td>
<td></td>
</tr>
<tr>
<td></td>
<td>warming, sea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>level rise, ozone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>depletion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Manmade</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disasters:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Industrial,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nuclear and Fire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hazards. Role of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>growing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>population and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>subsequent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>industrialization,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>urbanization and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>changing lifestyle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of human beings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in frequent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>occurrences of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>manmade disasters.</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Disaster Management, Policy and Administration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1 Disaster</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>management:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>meaning, concept,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>importance,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>objective of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disaster</td>
<td></td>
</tr>
<tr>
<td></td>
<td>management policy,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disaster risks in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>India, Paradigm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>shift in disaster</td>
<td></td>
</tr>
<tr>
<td></td>
<td>management.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.2 Policy and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>administration:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Importance and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>principles of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>disaster</td>
<td></td>
</tr>
<tr>
<td></td>
<td>management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>policies, command</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and coordination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of in disaster</td>
<td></td>
</tr>
<tr>
<td></td>
<td>management, rescue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>operations-how</td>
<td></td>
</tr>
<tr>
<td></td>
<td>to start with and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>how to proceed in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>due course of time,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>study of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>flowchart showing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the entire</td>
<td></td>
</tr>
<tr>
<td></td>
<td>process.</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Institutional Framework for Disaster Management in India:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1 Importance of</td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>public awareness,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preparation and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>execution of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>emergency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>program. Scope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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></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>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Financing Relief Measures:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.1 Ways to raise</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>finance for relief</td>
<td></td>
</tr>
<tr>
<td></td>
<td>expenditure, role</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of government</td>
<td></td>
</tr>
<tr>
<td></td>
<td>agencies and NGO’s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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></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:

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:
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 question need to be solved.

REFERENCES:

5. ‘Disaster management & rehabilitation’ by RajdeepDasgupta, 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)
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>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Energy Scenario:</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Energy Audit Principles:</td>
<td></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>08</td>
</tr>
<tr>
<td>03</td>
<td>Energy Management and Energy Conservation in Electrical System:</td>
<td></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>10</td>
</tr>
<tr>
<td>04</td>
<td>Energy Management and Energy Conservation in Thermal Systems:</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>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Energy Performance Assessment:</td>
<td></td>
</tr>
<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>04</td>
</tr>
<tr>
<td>06</td>
<td>Energy conservation in Buildings:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources</td>
<td>03</td>
</tr>
</tbody>
</table>
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:
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 question need to be solved.

REFERENCES:
1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
8. www.energymanagertraining.com
9. www.bee-india.nic.in
The laboratory will focus on the following:

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Lab Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>3D - Modeling, Assembly &amp; Drafting</td>
<td>5</td>
</tr>
<tr>
<td>02</td>
<td>Kinematic &amp;Kinetic Analysis of Mechanisms</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>Finite Element Analysis (FEA) or Computational Fluid Dynamics (CFD) or Multibody dynamics (MBD)</td>
<td>4</td>
</tr>
</tbody>
</table>

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners
The laboratory will focus on the following:

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Lab Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Automation using Pneumatics and Hydraulics</td>
<td>4</td>
</tr>
<tr>
<td>02</td>
<td>Programmable logic controllers</td>
<td>3</td>
</tr>
<tr>
<td>03</td>
<td>Interfacing Servo motor/Stepper motor /Keyboard etc. with Micro controller</td>
<td>3</td>
</tr>
<tr>
<td>04</td>
<td>Programming &amp; Manipulating an Industrial Manipulator</td>
<td>3</td>
</tr>
</tbody>
</table>

**Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
Course Code | Course Name | Credits
---|---|---
CCC201 | Robotics | 04

Course Objectives

1. To familiarize the students with robotic systems and their applications in flexible or agile manufacturing.
2. To make conversant with robotic element / peripherals, their selection and interface with manufacturing equipments.
3. To explain the basics of robot kinematics.
4. To explain the applicability of machine vision and various image processing methods.
5. Students should have knowledge of path control and trajectory planning.

Course Outcomes: Learners will be able

1. To know the robot systems and their applications in agile manufacturing.
2. To have knowledge of robotic peripherals, their selection and their utility.
3. To have knowledge of basic robot kinematics.
4. Be acquainted with various image processing techniques.
5. To know path control and different trajectory planning.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| 01 | **Introduction:** Automation & robotics, Robotic System & Anatomy Classification, Future Prospects.  
**Robotic Application in Manufacturing:** Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors.  
**Social Issues and Economics of robotics**  
**Drives:** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators, Power Transmission Systems. | 10 |
| 02 | **Robot & its Peripherals:** End Effecters - types, Mechanical & other grippers, Tool as end effector  
**Sensors:** Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems  
**Robotic Cell Design & Control.** | 08 |
| 03 | **Robot Kinematics:**  
Coordinate Frames, Rotations, Homogeneous Coordinates, Arm Equation of Planer Robot, Four axis SCARA Robot, TCV, Inverse Kinematics of Planer Robot, Four Axis SCARA Robot. | 10 |
| 04 | **Trajectory Planning & Robot Dynamics:**  
Manipulator Path Control- Linear, Quadratic and Cubic Interpolation, Work Space Analysis, Robot Dynamics –Langrangian Dynamics of one and two link robot arm. | 08 |
| 05 | **Machine Vision:**  
Introduction, Low level & High level vision, Sensing & Digitizing, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Noises in Image, Applications, | 08 |
Programming For Robots: Methods, Robot programme as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot


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:

1. YoremKoren, “Robotics for Engineers”
2. J. F. Engelberger, “Robotics in Practice”
5. Mark Spong, “Robot Dynamics and Control”, Wiley India
6. John Craig, “Robotics”
8. Groover and Simmers,”Industrial Robotics”
9. Ernest Deoblin,”Measurement systems”
10. Beckwith and Lewisbuck, “Mechanical Measurements”
11. K. Ogata,“Modern Control Engineering”, PHI
12. Benjamin Kuo, “Automatic Control Systems”, Wiley India
Course Code | Course Name                  | Credits
-------------|------------------------------|--------
CCC202       | Advanced Manufacturing Technology | 04     

Objectives
1. To educate students about new advanced materials, their manufacturing techniques and systems.
2. To understand various unconventional manufacturing techniques, coating technologies for improvement of surface qualities.
3. To integrate manufacturing elements within an organization and understand E-manufacturing and collaborative manufacturing.

Outcomes: Learner will be able to…
1. Understand and apply various advanced manufacturing techniques
2. Analyse and optimise system requirements for advanced manufacturing systems
3. Understand the relevance of cloud computing in manufacturing domain by integration of manufacturing elements and usage of web based elements

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Advanced Manufacturing Technology</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Need, examples with at least 2 case studies. Introduction to various processes of manufacturing and shaping of metals, ceramics, plastics, composites, polymers, and natural materials such as wood, rubber etc</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Advanced Manufacturing processes – Introduction, Construction, Working principle, Types, Process parameters, problems, merits, demerits and applications of: Chemical Machining, Ultrasonic Machining, Electro-Chemical Machining, Electric Discharge Machining, Electron Beam Machining, Plasma Arc Machining, Laser beam Machining and Ion Beam Machining</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>Surface Treatments – Scope, Cleaners, Methods of cleaning, surface coating types, Ceramic and organic methods of coating, economics of coating, Electro forming, CVD and PVD coating, Thermal spraying, Ion Implantations, Diffusion coating, Diamond coating and cladding</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>Advanced Manufacturing Systems: Components of Manufacturing system, Single station manufacturing cell, Manual Assembly lines, line balancing Algorithm, Mixed model Assembly lines, Alternative Assembly systems, Automated production lines, Applications, Analysis of Transfer Lines. MRP-I &amp; MRP-II Introduction to Rapid manufacturing and Tooling</td>
<td>15</td>
</tr>
<tr>
<td>05</td>
<td>Integration of Manufacturing Elements – Process Flow Design and Introduction to Simulated Factory project using case studies. <strong>E-Manufacturing</strong> – Nano Manufacturing techniques and micro-machining, High speed machining and hot machining</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td>Collaborative Manufacturing: Definition and Concept, Aims of Collaborative Manufacturing, Business Process Change Considerations for Collaborative Manufacturing, Enabling Technologies for Collaborative Manufacturing, Benefits and Limitations of Collaborative Manufacturing, Cloud Manufacturing Methods, Models and Tools for Enterprise Interoperability, Detail case studies on various aspects of Collaborative Manufacturing</td>
<td>05</td>
</tr>
</tbody>
</table>
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. HMT Manual, Non-Traditional Machining Methods
10. Advanced Machining Processes – V.K. Jain – Allied Publications
### Course Code: CCC203  
**Course Name:** Computer Aided Machining (CAM)  
**Credits:** 04

**Objectives:**
1. To familiarize with CNC hardware.
2. To familiarize with operation and programming of CNC machines.
3. To familiarize with concepts of computer aided machining and its significance.

**Outcomes:** Learner will be able to…
1. Write and run CNC program for Turning and Milling.
2. Write program for CNC EDM and Wire EDM.
3. Do simple hardware designs.
4. Do interfacing of drive systems with the machines.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
</table>
| 01     | **Introduction to Computer Numerical Control.**  
History of various NC machines like TNC, NC, CNC, DNC, Elements of CAM, Various CNC applications in different industries, Computer control concepts, Data processing units, Binary execution | 8 |
| 02     | **CNC Hardware**  
Structure of CNC machine tools, Spindle design, Spindle and axis drives, Various actuation systems and feedback devices like encoder, tachogenerator, etc. | 8 |
| 03     | **CNC Control System and Machine Tools.**  
CNC motion controller, Linear, circular, helical interpolator, Positioning and contouring control loops, MCU, adaptive control system, CNC machining centre, turning, grinding, EDM, wire EDM, boring, turn mill and CNC gear cutting, Study of two control systems. | 8 |
| 04     | **CNC Tooling.**  
Latest CNC tool materials and manufacturing, Turning and milling tool geometry, Tool probing and presetting, Automatic Pallet Changer (APC) and Automatic Turret Changer (ATC), Study of various probes and special tools. | 10 |
| 05     | **CNC Programming.**  
Part programming fundamentals, Manual part programming methods, Various G & M codes, Absolute and incremental system, TNRC, Tool length and diameter compensation, Programming of turning, machining centre and EDM, Use of canned cycles, loop, jump, subroutines, CAPP, APT, Post processing | 10 |
| 06     | R Parameter programming, Macros, 3D programming | 8 |
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:
2. Hans B. Kief and J. Frederick Waters “CNC” Glencae Macmillan / McGraw Hill
Course Code: CCDLO2021  
Course Name: Smart Materials  
Credits: 04

Objectives:
1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials.

Outcomes: Learner will be able to…
1. Understand working of smart materials and their application as actuator and sensor.
2. Select an appropriate smart material for a given application.
3. Identify applicability of smart materials for new prospective smart structures.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Smart Materials</strong>: Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHSS)</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Important Concepts of Smart Materials</strong>: artificial skins, artificial muscles, biomimetic materials, materials with tunable responses, non-linear properties, self healing materials, adaptive structures, self replicating materials/structures, self assembly, inch worm devices, hysteresis, integrated sensing and actuation</td>
<td>10</td>
</tr>
</tbody>
</table>
| 03     | **Overview of the following materials** with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc)  
1. Piezoelectric Materials  
2. Magnetostrictive Materials  
3. Shape Memory Alloys  
4. Electroactive Polymers | 10 |
| 04     | **Overview of the following materials** with focus on synthesis, strengths and weaknesses, and applications  
1. Ferrofluids and Magneto rheological Fluids and applications in dampers  
2. Soft Matter and its applications as smart skins, smart textiles etc  
3. Carbon Nanotubes and Carbon nano-structures and its applications  
4. Thermoelectric Materials and Peltier devices | 08 |
| 05     | **Smart Materials for Energy Applications**: Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations | 08 |
| 06     | **Composite Materials**: Introduction to Composite Materials, Nano Composite Materials, Soft conducting and magnetic solids, active fiber composites, Self-heating cement/ polymer matrix composites | 08 |
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 acquaint with various rapid manufacturing technologies.
2. To familiarize with various software solutions for designing and developing products using rapid manufacturing techniques.
3. To familiarize with applications of these techniques in various engineering and biomedical fields.

### Outcomes:
Learner will be able to...
1. Demonstrate understanding of various rapid manufacturing techniques.
2. Develop competency in designing and developing products using rapid manufacturing technology.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Rapid Manufacturing</strong>&lt;br&gt;• Historical Development&lt;br&gt;• Additive, Subtractive and Formative Manufacturing&lt;br&gt;• Applications: Design, Planning, Manufacturing and Tooling&lt;br&gt;• Applications: Automotive, Aerospace, Electronics, Jewelry, Bio-Medical&lt;br&gt;• Fundamentals of Rapid Prototyping and Manufacturing, Design Process&lt;br&gt;• Rapid Prototyping and Manufacturing Process Chain&lt;br&gt;• Classification of Additive Manufacturing Processes</td>
<td>8</td>
</tr>
<tr>
<td>02</td>
<td><strong>Rapid Manufacturing System and Methodology</strong>&lt;br&gt;• Subsystems of RP machine&lt;br&gt;• Optical System&lt;br&gt;• Mechanical Scanning System&lt;br&gt;• Computer Interfacing hardware, DAQs&lt;br&gt;• Signal Flow, 3D Model to RP Prototype&lt;br&gt;• Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, SOLIDWORKS, IDEAs etc.)&lt;br&gt;• File Formats: IGES, STEP, DXF, STL&lt;br&gt;• Slicing and Scan Path Generation Algorithms&lt;br&gt;• Data Conversion and Transmission&lt;br&gt;• Data Validity and Repair&lt;br&gt;• Preprocessing and Post-processing&lt;br&gt;• Properties of the prototype/part: Material properties, color, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>Liquid Based Rapid Prototyping Systems</strong>&lt;br&gt;• Materials&lt;br&gt;• Stereolithography&lt;br&gt;• Solid Ground Curing&lt;br&gt;• Solid Object UV (Ultra-Violet) Printer&lt;br&gt;• Micro-stereolithography</td>
<td>8</td>
</tr>
<tr>
<td>04</td>
<td><strong>Solid Based Rapid Prototyping Systems</strong>&lt;br&gt;• Materials&lt;br&gt;• LOM (Laminated Object Manufacturing) System&lt;br&gt;• FDM (Fused Deposition Modeling) System&lt;br&gt;• Multi-Jet Modeling (MJM) System&lt;br&gt;• Model Maker and Pattern Master&lt;br&gt;• Shape Deposition Manufacturing Process</td>
<td>8</td>
</tr>
</tbody>
</table>
### Powder Based Rapid Prototyping Systems

- Materials
- SLS (Selective Laser Sintering)
- (3DP) Three-Dimensional Printing
- (LENS) Laser Engineered Net Shaping
- (MJS) Multiphase Jet Solidification
- (EBM) Electron Beam Melting

### Advances in Rapid Manufacturing and Case Studies

- Case Study: Investment Casting with RP
- Case Study: Wind-Tunnel Testing with RP Models,
- Case Study: Manufacture of Human implants and prosthesis

### 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:

Course Prerequisite:
Sensors, Actuators, Instrumentation system and VLSI Technology

Objectives
1. To understand the basic characteristics of MEMS and its processing steps.
2. To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
3. To understand the of basic design and operation of MEMS sensors and actuators with proper characterization.
4. To make use of the MEMS devices for real time applications

Outcomes: Learner will be able to
1. Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling
2. Select the appropriate material and processes while fabrication of MEMS devices
3. Design and simulate MEMS devices and system using standard simulation tools.
4. Develop different concepts of micro system sensors and actuators for real-world applications.

<table>
<thead>
<tr>
<th>Module No.</th>
<th>Detailed contents</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction to MEMS</strong>&lt;br&gt;Introduction to MEMS &amp; its characteristics, Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications</td>
<td>04</td>
</tr>
<tr>
<td>2</td>
<td><strong>MEMS Materials and their Properties</strong>&lt;br&gt;Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties: Young modulus, Poisson’s ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td><strong>Fabrication Processes common to MEMS</strong>&lt;br&gt;Understanding MEMS Processes &amp; Process parameters for: Cleaning, Growth &amp; Deposition, Ion Implantation &amp; Diffusion, Annealing, Lithography. Understanding selection of Fab processes based on Applications</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td><strong>MEMS Specific Fabrication Processes</strong>&lt;br&gt;Understanding MEMS Processes &amp; Process parameters for: Wet &amp; Dry etching, Bulk &amp; Surface Micromachining, Die, Wire &amp; Wafer Bonding, Dicing, Packaging. Understanding selection of Fab processes based on Applications</td>
<td>08</td>
</tr>
<tr>
<td>5</td>
<td><strong>MEMS Devices: Architecture and working</strong>&lt;br&gt;basic quantitative behaviour of Cantilevers, Micro-heaters, Accelerometers, Pressure Sensors, Micro-mirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices. Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, &amp; importance of these measurements in studying device behavior, MEMS Reliability</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td><strong>Applications of MEMS devices</strong>&lt;br&gt;Industrial applications with detailed understanding of role of MEMS as sensors and actuators with proper case studies.</td>
<td>10</td>
</tr>
</tbody>
</table>
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 questions
2. All questions 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. An Introduction to Microelectromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
2. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
3. Microsystem Design - by S. Senturia; Publisher: Springer
4. Analysis and Design Principles of MEMS Devices - MinhangBao; Publisher: Elsevier Science
5. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition
6. Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press
7. Micromachined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill
## Course Code
CCDLO2024

### Course Name
Optimization

### Credits
04

## Objectives
1. To understand various linear, nonlinear and other optimization techniques.
2. To understand various decision making methods.

## Outcomes:
Learner will be able to…

1. Formulate the problem as LPP and analyse the sensitivity of a decision variable.
2. Apply various linear and non linear techniques for problem solving in various domain.
3. Apply decision making methods for problem in manufacturing environment and other domain.

## Module Detailed content Hours

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Basic Concepts:</strong> Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Overview of optimization technique, Interdisciplinary nature, Introduction to related software.</td>
<td>06</td>
</tr>
<tr>
<td>2</td>
<td><strong>Linear Programming Problem:</strong> Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis.</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td><strong>Integer L.P. Model:</strong> Gomory's cutting plane method, Branch &amp; Bound Technique. <strong>Non L.P. Model:</strong> Lagrangian method &amp; Kuhn tucker Method.</td>
<td>08</td>
</tr>
<tr>
<td>4</td>
<td><strong>Multi Criterion Decision-making (MCDM) Methods:</strong> Introduction to multi criterion optimization, Simple Additive Weighting (SAW) Method, Weighted Product Method (WPM), Analytic Network Process (ANP), Analytic Hierarchy Process (AHP) Method, TOPSIS Method, PROMETHEE. <strong>Multi Objective Decision making (MODM) Methods:</strong> Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming.</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td><strong>Newtonian Method:</strong> Newton's method, Marquardt's method, Quasi Newton method. <strong>Discrete Event Simulation:</strong> Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.</td>
<td>08</td>
</tr>
</tbody>
</table>
### Robust Design Methods:

- DOE and Taguchi techniques
- Response Surface Method: Response Surface, Least-Squares Methods, Two-Level Factorial Design, Addition of Center Points, Central Composite Design (CCD), Sequential Nature of RSM.

---

### 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 questions
2. All questions 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:

2. Pablo Pedregal, "Introduction to Optimization", Springer
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 breakdown structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Project Management Foundation:</strong> Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical &amp; atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).</td>
<td>5</td>
</tr>
<tr>
<td>02</td>
<td><strong>Initiating Projects:</strong> How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development &amp; growth (forming, storming, norming &amp; performing), team dynamics.</td>
<td>6</td>
</tr>
<tr>
<td>03</td>
<td><strong>Project Planning and Scheduling:</strong> Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANNT chart. Introduction to Project Management Information System (PMIS).</td>
<td>8</td>
</tr>
<tr>
<td>05</td>
<td><strong>5.1 Executing Projects:</strong> Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. <strong>5.2 Monitoring and Controlling Projects:</strong> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. <strong>5.3 Project Contracting</strong> Project procurement management, contracting and outsourcing.</td>
<td>8</td>
</tr>
<tr>
<td>06</td>
<td><strong>6.1 Project Leadership and Ethics:</strong> Introduction to project leadership, ethics in projects. Multicultural and virtual projects. <strong>6.2 Closing the Project:</strong> 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.</td>
<td>6</td>
</tr>
</tbody>
</table>
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:
1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
4. Gopalan, Project Management, Wiley India
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
</tr>
</thead>
</table>
| 01     | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.  
**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.  
**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market  
**Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges |
| 02     | **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. |
| 03     | **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. |
| 04     | **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. |
| 05     | **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 |
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:
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2023</td>
<td>Entrepreneurship Development and Management</td>
<td>03</td>
</tr>
</tbody>
</table>

**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>
</table>
| 01     | **Overview Of Entrepreneurship:** 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                                      | 04  |
| 02     | **Business Plans And Importance Of Capital To Entrepreneurship:** 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  
        **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations | 09  |
| 03     | Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises                                                                                   | 05  |
| 04     | **Indian Environment for Entrepreneurship:** key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | 08  |
| 05     | **Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing                                                                 | 08  |
| 06     | **Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business                                                                                   | 05  |
**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:**

1. PoornimaCharantimath, 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. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
10. LaghuUdyogSamachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in
Course Code | Course Name | Credits
--- | --- | ---
ILO2024 | Human Resource Management | 03

Objectives:
1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today’s organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group 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.  
- Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. | 5 |
• Training & Development: Identification of Training Needs, Training Methods

<table>
<thead>
<tr>
<th>05</th>
<th>Emerging Trends in HR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>06</th>
<th>HR &amp; MIS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries</td>
</tr>
<tr>
<td></td>
<td>Strategic HRM</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>06</th>
<th>Labor Laws &amp; Industrial Relations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</td>
</tr>
</tbody>
</table>

**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:**

Course Code | Course Name | Credits
-------------|-------------|---------
ILO2025 | Professional Ethics and Corporate Social Responsibility (CSR) | 03

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

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

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

**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:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2026</td>
<td>Research Methodology</td>
<td>03</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 01     | **Introduction and Basic Research Concepts**  
1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology  
1.2 Need of Research in Business and Social Sciences  
1.3 Objectives of Research  
1.4 Issues and Problems in Research  
1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | 09 |
| 02     | **Types of Research**  
2.1 Basic Research  
2.2 Applied Research  
2.3 Descriptive Research  
2.4 Analytical Research  
2.5 Empirical Research  
2.6 Qualitative and Quantitative Approaches | 07 |
| 03     | **Research Design and Sample Design**  
3.1 Research Design – Meaning, Types and Significance  
3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | 07 |
| 04     | **Research Methodology**  
4.1 Meaning of Research Methodology  
4.2 Stages in Scientific Research Process:  
a. Identification and Selection of Research Problem  
b. Formulation of Research Problem  
c. Review of Literature  
d. Formulation of Hypothesis  
e. Formulation of research Design  
f. Sample Design  
g. Data Collection  
h. Data Analysis  
i. Hypothesis testing and Interpretation of Data  
j. Preparation of Research Report | 08 |
| 05     | **Formulating Research Problem**  
5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 04 |
| 06     | **Outcome of Research**  
6.1 Preparation of the report on conclusion reached  
6.2 Validity Testing & Ethical Issues  
6.3 Suggestions and Recommendation | 04 |
**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:**
Course Code | Course Name | Credits
---|---|---
ILO2027 | IPR and Patenting | 03

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hr</th>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>
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:
Course Code: ILO2028
Course Name: Digital Business Management
Credits: 03

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Introduction to Digital Business</strong>- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts, Difference between physical economy and digital economy, <strong>Drivers of digital business</strong>- Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services), Opportunities and Challenges in Digital Business,</td>
<td>09</td>
</tr>
</tbody>
</table>
| 2      | **Overview of E-Commerce**
E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement, B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals, Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing, EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | 06 |
| 3      | **Digital Business Support services**: ERP as e-business backbone, knowledge Topo Apps, Information and referral system, **Application Development**: Building Digital business Applications and Infrastructure | 06 |
| 6      | **Materializing e-business: From Idea to Realization**-Business plan preparation, Case Studies and presentations | 08 |
**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:**

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.</td>
<td>06</td>
</tr>
<tr>
<td>03</td>
<td>Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td>Scope of Environment Management, Role &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>
<td>03</td>
</tr>
</tbody>
</table>

**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:
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
The laboratory will focus on the following:
1. CNC Turning, Milling, EDM, Wire-EDM and Modeling
A total of 13 laboratory assignments should be based on the following:
2. Operation, programming of above machines.
3. Tool path Simulation using software.

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners
The laboratory will focus on the following:

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Content</th>
<th>Lab Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3D Modeling and creating STL files</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>3D Printing of individual components</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3D Printing of multiple components in assembly</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Use of 3D printing or any other rapid manufacturing equipment</td>
<td>4</td>
</tr>
</tbody>
</table>

The laboratory assignments should be based on the following:
1. Introduction to Rapid manufacturing.
2. Rapid manufacturing system.
4. Case studies of Rapid manufacturing system.

Assessment:

**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>
</tr>
</thead>
<tbody>
<tr>
<td>CCS301</td>
<td>Seminar</td>
<td>03</td>
</tr>
</tbody>
</table>

**Guidelines for Seminar**

- Seminar should be based on thrust areas in Mechanical Engineering (Thermal Engineering 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
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCD301/</td>
<td>Dissertation (I and II)</td>
<td>12 + 15</td>
</tr>
<tr>
<td>CCD401</td>
<td></td>
<td></td>
</tr>
</tbody>
</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)

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