CIRCULAR:-

A reference is invited to the syllabi relating to the Master of Engineering (Mechanical) Manufacturing System Engineering degree course vide this office Circular No. UG/151 of 2012-13, dated 20th March, 2013 and the Principals of affiliated Colleges in Engineering are hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 vide item No. 4.69 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) Manufacturing System Engineering (Sem. I to IV), which is available on the University’s web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032
November, 2016

To,
The Principals of affiliated Colleges in Engineering.

A.C/ 4.69/14/07/2016.

***************
No. UG/139A of 2016 MUMBAI-400 032 November, 2016

Copy forwarded with compliments for information to:-

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

(M.A.Khan)
REGISTRAR

... PTO
UNIVERSITY OF MUMBAI

Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)
MANUFACTURING SYSTEMS ENGINEERING

(As per Choice Based Credit and Grading System
with effect from the academic year 2016–2017)
From Co-ordinator’s Desk:-

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

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

Choice Based Credit and Grading System enables a much-required shift in focus from teacher-centric to learner-centric education, since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes. Faculty of Technology has devised a transparent credit assignment policy, adopting a ten point scale to grade learner’s performance. Choice Based Credit and Grading System is implemented for Master of Engineering from the academic year 2016-2017.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai
Chairman’s Preamble:

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

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

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

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

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

Dr. S. M. Khot
Chairman, Board of Studies in Mechanical Engineering, University of Mumbai
# Program Structure for ME Mechanical Engineering (Thermal Engineering) 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>
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<tr>
<td></td>
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<td>Theory</td>
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</tr>
<tr>
<td>MSEC101</td>
<td>Product Design &amp; Development</td>
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<tr>
<td>MSEC102</td>
<td>Computer Integrated Manufacturing Systems</td>
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## Semester II

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University of Mumbai, ME (Mechanical) Manufacturing Systems Engineering, Rev 2016
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### Semester III

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### Semester IV

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*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
Dissertation I and II - 02 Hour / week / student
Objectives
1. The purpose of teaching this subject on Product Design & Development is to facilitate a deeper understanding & assimilation of key concepts of the topic to the learner.
2. It is also expected that the learner knows the state of the art methodologies and technologies in the subject.
3. The learner therefore is able to face the global challenges in this domain.

Outcomes: Learner will be able to…
1. Understand the basic design process
2. Understand Generic development process, Product Life Cycle & various state of the art tools/techniques used
3. Choose appropriate design method
4. Understand economic feasibility of the product
5. Understand the process of IP rights & Patenting.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>Design Process :</td>
<td>08</td>
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<tr>
<td>02</td>
<td>Development Process</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>Design Methods</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Design for Manufacturing &amp; Assembly, Design for Maintainability &amp; Environment, Sequential versus Concurrent Design, Robust Design &amp; Taguchi’s DOE. Legal, Social, Ethical issues related to Design.</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Industrial Design</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Product Costing &amp; Techno commercial Viability</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>Product Costing Elements / Levies, Value Engg / Value Analysis - Definition, Methodology, Economic Analysis, Qualitative &amp; Quantitative, Important Finance Ratios, Return on Investment, Return on Sales, Gross Profit Margin, Net Profit Margin, Case Studies</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Allied Issues</td>
<td>08</td>
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</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:

### Objectives
1. To understand overall aspects of manufacturing systems and the manufacturing supporting systems.
2. To understand the CIM database and database management system of a manufacturing firm.
3. To understand the functioning of computer integrated manufacturing Enterprise

### Outcomes:
1. Apply the knowledge and explore new dimension of research in the field of Computer Integrated Manufacturing.
2. Work in an integrated manufacturing industry

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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</thead>
</table>
| 01 | Introduction to CIM:  
- Background: Manufacturing systems and its support systems, Computer applications in Design and manufacture-Fundamentals of CAD, CAM.  
- Concurrent Engineering: Benefits and techniques of Concurrent Engineering, Framework for integration of Life-cycle phases in CE, Integrated Product Development (IPD), Product Life-Cycle Management (PLM), and Collaborative Product Development.  
- Introduction to CIM, Evolution, objectives, benefits, limitations, relationship between automation and CIM, CIM hardware and software, role and functioning of elements of CIM, CIM Wheel | 10 |
| 02 | Computer Process Monitoring and Control:  
- Computer Process Monitoring: Data logging systems-Data acquisition systems-Multilevel scanning.  
| 03 | Development and implementation of an FMS:  
- Planning phase, Integration, System configuration, FMS layouts, Simulation, FMS Project development steps. Project management, Equipment development, Host system development, planning, Hardware& Software development.  
- Automated Material Handling & Storage: Functions, Types, Analysis of material handling equipment’s, Design of Conveyor & AGV systems. Problems. Development for total material handling system. | 08 |
| 04 | Computer Aided Quality Control (CAQC):  
- Introduction, QC inspection and testing, the computer in QC, Automated inspection principles and methods, sensor technologies for automated inspection – contact and non-contact types, Computer aided testing, Integration of CAQC with CAD/CAM | 08 |
| 05 | Role of Information Systems:  
- Information requirements of manufacturing, group technology, computer aided process planning, computer integrated production planning systems, material requirements planning, capacity planning, shop floor control, automatic identification techniques.  
- CIM database and database management systems: Manufacturing Data: Types, sources, Database models, Architecture, Database Management System (DBMS), product Data Management (PDM), Advantages of PDM | 08 |
Enterprise Wide Integration in CIM and CIM 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.

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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. Vajpayee,“Principles of CIM” - Prentice-Hall of India.
## Course Code | Course Name | Credits
--- | --- | ---
MSEC103 | Quality Engineering | 04

### Objectives
1. To study fundamentals of statistical techniques.
2. To acquaint with various quality management tools.
3. To overcome obstacles for achieving a successful quality management.
4. To enable and understand Total Quality Management (TQM).

### Outcomes: Learner will be able to…
1. Demonstrate the understanding of modern quality concepts.
2. Demonstrate the understanding of statistical quality control charts
3. Apply the use of standard sampling plan.
4. Analyze the modern management trends in quality improvement.
5. Apply the use of concepts of TQM

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 01 | **Quality:**
Definition & Evolution of Quality, Quality Assurance, and Quality Characteristics (dimensions).
Quality Control, Quality tasks & means to control them, Quality costs concept & its categories, Cost reduction program and economics of quality | 08 |
| 02 | **Statistical Quality Control (SQC):**
Basic Concept of Statistical Quality Control (SQC), Statistical Tools in Quality Control. Concept & causes of variation, statistical aspect of control charting. Concept of rational sub-grouping and detecting patterns on the control charts, for variables and attributes: X and R, p, np, c and u charts; specification and tolerances, natural tolerance limits, specification limits, process capability ratio analysis and studies | 10 |
| 03 | **Acceptance Sampling:**
Concept of Acceptance Sampling, Lot by lot sampling process, types. Probability of acceptance in single, double, multiple and sequential sampling plans, OC curves, Producer’s risk and consumer’s risk. AQL, LTPD, AOQL, Concepts, standard sampling plans for AQL and LTPD, use of standard sampling plans, Introduction to Variable sampling plans | 08 |
| 04 | **Total Quality Management(TQM):**
Basic concepts of TQM, historical review, leadership, concepts, role of senior management, quality statements, plans for process parameters, Implementation of TQM, ISO 9000 quality system, Jurans Triology, Deming’s Approach to TQM, Zero defect Concept | 08 |
| 05 | **Total Productive Maintenance (TPM):**
History and Impact of TPM, Overall Equipment Effectiveness (OEE). Developing the TPM implementation Plan, Preventive Maintenance, techniques-FMEA, POKA-YOKE and Future of TPM | 08 |
<table>
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<tr>
<th>Module</th>
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<tbody>
<tr>
<td>06</td>
<td><strong>6σ &amp; Modern Management Tools:</strong> Evolution of six sigma quality approach, steps involved in the application of six sigma, six sigma and Indian Industries, Six sigma 6.2 concept of process capability, Basic &amp; Modern tools in quality improvement, Benchmarking, KAIZEN, JIT, 5-S, Taguchi quality loss function. Introduction to DOE and RSM.</td>
<td>10</td>
</tr>
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**Assessment:**

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

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

**References:**

1. Statistical Quality Control By M.Mahajan
10. J.Juran, “Quality Control Handbook,Mcgraw Hill USA
11. A.V.Feigenbaum, “Total quality control” Mcgraw hill int.edition USA
Course Code | Course Name | Credits
--- | --- | ---
MSEDLO 1011 | Advanced Materials Science | 04

**Objectives**

1. The aims of the course is to give fundamental knowledge about type of materials, their usage, properties and characteristics, which are important in engineering design.
2. It is also aimed to give a theoretical background about the analysis of behaviour of engineering materials by emphasizing important relationships between internal structure and properties.
3. Understand the relationship between Nano/microstructure, characterization, properties and processing and design of materials.
4. Understand the behaviour of composite material.
5. Differentiate the properties and applications of metals, ceramics, polymers and composite materials.
6. Understand the significance, properties and applications of nanomaterials

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

1. Demonstrate extensive knowledge and skills related to selected topics covered by the course.
2. Use this knowledge and skills to discuss and analyse relevant problems connected to these topics.
3. Prepare and present selected topics from the course in form of Power-Point presentations for colleagues and fellow students

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Review of fundamentals:</strong> Covalent, Ionic, Metallic and Van-der Walls Bond, Bond strength and melting point, Crystalline structures, Vacancies, Dislocations and other crystal defects. Metals Vs Alloys – Microstructure characterization</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Mechanical behaviour of metals and alloys:</strong> Elastic and plastic behaviours, Tensile &amp; compressive stress-strain relations for elastic behaviours. Fracture toughness, fatigue failure, creep failure, wear and abrasion</td>
<td>05</td>
</tr>
<tr>
<td>03</td>
<td><strong>Metals and alloys:</strong> HSLA Steels, tool and die materials, alloy cast-irons, stainless steels, PH and Maraging steels. Materials for low temperature applications, refractory metals and super alloys, hard field steels, ball bearing steels, automobile alloys and aerospace alloys</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td><strong>Polymers:</strong> Definitions, Classifications, Monomers, Polymerization principles, Addition, Condensation, Mass, Suspensions and emulsion polymerizations Classification – Thermoplastic and Thermosets, Crystalline and Amorphous, Natural and Synthetic, Linear, branched and cross-linked; Engineering, commodity and speciality polymers Homo polymers and co-polymers, Elastomers and Thermoplastic elastomers Polymer Blends and Alloys, Liquid crystal polymers, Polymer foams Properties and applications of polymers, Viscoelastic, Thermal, Electrical, Optical, Environmental &amp; Mechanical behaviour. Important thermoplastics and thermosets - their moulding characteristics, properties and applications</td>
<td>18</td>
</tr>
</tbody>
</table>
| 05 | Ceramics and Composite:  
Various ceramic materials and their applications Engineering ceramics,  
Environmental influence on ceramics  
Ceramic crystal structures – Binary and Ternary structures  
**Fundamentals of composite:**  
Definition, Classification of composite materials, Laws of mixtures, Factors affecting composite properties, Interfacial bonding, Mechanical Behaviour of Composites,  
Glass fibres, Carbon fibres, Silicon Carbide fibres, and Metallic Glasses |
|---|---|
| 06 | Advanced Materials:  
Concept of nano materials, scale and dimensional aspects for preparing nano materials synthesis and properties, applications of nano materials.  
Biomaterials, super alloys, shape memory alloys. Carbon as a special material, Smart materials. Nano -Physics, Preparation of Nano phase materials -Sol -gel, electro- deposition, plasma assisted deposition, Molecular beam epitaxy etc. Advanced nano -composites Thin film preparation of metal oxides, Application of Nanostructured Materials |

**Assessment:**

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**References:**

Materials Science by R S Khurmi & R S Sedha S Chand & Co  
1. Mechanical Metallurgy by Georg Dieter (Mc Grawhill)  
3. Plastics Engg by R J Crawford Butterworth Hieneman  
4. Composite Materials Science & Engineering by Krishnan Chowla (Springer Verlag)  
5. Plastics Technology Handbook by M Chandra & S K Roy Marcel Dekker  
6. Mechanical properties of ceramics by John B Wactman John Willey & Sons  
7. Metal Matrix composites : Thermomechanical behaviour by Taya M & Arsenault R J (Pergamon press oxford)  
### Course Details

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSEDLO 1012</td>
<td>World Class Manufacturing</td>
<td>04</td>
</tr>
</tbody>
</table>

### Objectives
1. Help the learner understand and assimilate deeper insights into the opportunities & challenges faced by manufacturing as a domain today.
2. Introduce the learner to be prepared for facing the demands and complexities of a global market place

### Outcomes: Learner will be able to…
1. Understand the relevance and basics of World Class Manufacturing, the current Status of Indian Manufacturing scenario and have the ability to design and develop a roadmap for world class manufacturing.
2. Prepare them for meeting the challenges, the Indian manufacturer’s face, as it evolves from a domestic to a world class global manufacturer status

### Module Details

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<thead>
<tr>
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<tbody>
<tr>
<td>01</td>
<td><strong>Historical Perspective</strong>&lt;br&gt;World class manufacturing organizations, Models for manufacturing excellence: Schonberger, Halls, Gunn and Maskell models, Business Excellence. Globalization and International Business; Global Competitiveness and Manufacturing Excellence, Manufacturing and Information age competition; Manufacturing challenges and Problems in Manufacturing Industries</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>System and Tools for World Class Manufacturing</strong>&lt;br&gt;Improving Product &amp; Process Design – Lean Production – SQC, FMS, Rapid Prototyping, Poka Yoke, 5-S, 3 M, JIT, Product Mix, Optimization, Procurement &amp; stores practices. Total Productive maintenance, Visual Control</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td><strong>Benchmark, Bottlenecks and Best Practices</strong>&lt;br&gt;Concepts of benchmarking, Bottleneck and best practices, Best performers Gaining competitive edge through world class manufacturing Value added manufacturing , Value Stream mapping, Eliminating waste, Toyota Production System, Example</td>
<td>07</td>
</tr>
<tr>
<td>04</td>
<td><strong>HR Dimensions in WCM – WCM Strategy Formulation</strong>&lt;br&gt;Adding value to the organization, Organizational learning – techniques of removing Root cause of problems – People as problem solvers, New organizational structures. Associates, Facilitators – Teamsmanship, Motivation and reward in the age of continuous improvement</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Typical Characteristics of WCM Companies</strong>&lt;br&gt;Performance indicators like POP, TOPP and AMBITE systems– what is world class Performance –Six Sigma philosophy</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Competitive Indian Manufacturing</strong>&lt;br&gt;Manufacturing Performance and competitiveness of Indian Firms, Manufacturing objectives and Strategy; Usage of Management Tools and Technologies. Manufacturing Management Practices; IT Infrastructure and Practices; Strategic Intent Framework; Breadth and Integration of IT Infrastructure. The Future WCM Manufacturing strategy: Futile search for an Elusive Link, Manufacturing Strategic Intent classification translating into action <strong>WCM - the Indian Scenario</strong>&lt;br&gt;Case studies on leading Indian companies moving towards world class manufacturing –Task Ahead. Green Manufacturing, Clean manufacturing, Agile manufacturing</td>
<td>14</td>
</tr>
</tbody>
</table>
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**References:**

1. Sahay B.S., Saxena KBC and Ashish Kumar, ”World Class Manufacturing - Strategic Perspective” Mac Milan Publications, New Delhi.
Objectives
1. Define KM, learning organizations, intellectual capital and understand the role of knowledge management in organizations and its successful system life cycle.
2. Identify and use tools and techniques of KM for the different stages of creation, acquisition, transfer and management of knowledge.
3. Analyze and evaluate tangible and intangible knowledge assets and address current KM issues.
4. Evaluate the impact of new technologies such as networks and Internet/intranet role in managing knowledge.
5. By understanding of the importance of intellectual capital, articulate how to create the competitive advantage in manufacturing and other organizations.

Outcomes: Learner will be able to…
1. Understand the importance of intellectual capital to benefit in the competitive advantage and how to create conducive KM infrastructure in organizations.
2. Choose application packages in KM and the issues in designing and developing knowledge databases (including intranets and groupware).
3. Develop a working knowledge in the area through focused projects and career options.
4. Analyze impacts of implementation of KM infrastructure.

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<th>Hrs.</th>
</tr>
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<tbody>
<tr>
<td>03</td>
<td>Knowledge Capturing Evaluating the Expert – Developing a Relationship with Experts – Fuzzy Reasoning. The Quality of Knowledge – Knowledge Capturing or discovery Techniques, Brain Storming, storytelling, knowledge sharing,— Protocol Analysis – knowledge application systems (expert systems and decision support systems- Consensus Decision Making – Repertory Grid for competency mapping- Concept Mapping and use of software’s</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Knowledge Transfer and Sharing Transfer Methods, Role of the Internet, Knowledge Transfer in e-world, KM System, Tools, Neural Network, Association Rules, Classification Trees, and Data Mining. Business Intelligence, Decision Making Architecture, Data Management, Knowledge Management Protocols, Managing Knowledge Workers.</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Knowledge Management in Manufacturing How to foster innovation within own organizations - policy adoption of new</td>
<td>08</td>
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References:

Course Code: MS E DLO1014
Course Name: Precision Engineering
Credits: 04

Objectives
1. To understand the need for precision and application.
2. To understand concepts of accuracy and errors due to numerical interpolation.
3. To understand the aspects of precision engineering like precision Materials, Measurement and Machining

Outcomes: Learner will be able to…
1. Enhance his/her knowledge in Precision Engineering and its applications.
2. Explore new dimension of research in the field of precision and ultra-precision materials and Machining methods

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<thead>
<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</td>
<td>Accuracy and precision: Introduction - concept of accuracy and precision, Need for high precision, Accuracy of numerical control systems. Errors due to numerical interpolation - displacement measurement system and velocity lags</td>
<td>07</td>
</tr>
<tr>
<td>02</td>
<td>Geometric Dimensioning And Tolerancing: Interpretation, measurement and application of form tolerances, datum system. Targets –tolerance of position Tolerance zone conversions , Surfaces, features, features of size, datum features-Datum, oddly configured and curved surfaces as datum features, equalizing datum</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td>Precision Materials and Machining: Diamond – types-single crystal- PCD, Natural-synthetic CBN, Ceramics – coated metals and nonmetals, High performance polymer, alloys, refractory metals: cutting tools performance, Components of instruments, Jewels self-Lubrication, smart materials – properties, testing, applications. Precision Machining :Precision grinding- High-speed grinding, High-speed Milling-Micromachining, Diamond turning-MEMS, micro finishing process</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td>Precision Measuring Systems: Units of length, legal basis for length measurement, Traceability – Processing system of nanometer accuracies, LASER light source - LASER interferometer, LASER alignment telescope, LASER micrometer-on-line and in-process measurements of diameter and surface roughness using LASER - Micro holes and topography measurements- In processing or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems. Straightness, Flatness measurement – Optoelectronic Measurement Systems in Metrology, Opto electronic devices contact and non-contact types Applications - Tool wear measurement, 3D Surface roughness, and Pattern generation studies</td>
<td>12</td>
</tr>
<tr>
<td>06</td>
<td>Computer Integrated Quality Assurance: Concept of Total quality control &amp; quality assurance, Zero defects-POKAYOKE Statistical evaluation of data using computer, CNC CMM applications - Computer Aided measurement, data integration of 3D-CMM</td>
<td>08</td>
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References:

2. JAMESD. MEADOWS, - “Geometric Dimensioning and Tolerancing ", Marcel Dekker Inc.1995.
4. WATSON J. , " Optoelectronics " - Van Nostrand Rein hold(UK)Co ltd.,1988
5. ROBERT.G. SEIPPEL, - “Optoelectronics for technology and engineering ", Prentice Hall NewJersey,1989
7. John Frederick Wise Galyer, Charles Reginald Shotbolt,"Metrology for Engineers”,Cassell
### Objectives:
1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

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

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<tr>
<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</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><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>09</td>
</tr>
<tr>
<td>04</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>05</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>
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<tbody>
<tr>
<td>ILO 1012</td>
<td>Reliability Engineering</td>
<td>03</td>
</tr>
</tbody>
</table>

**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

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<thead>
<tr>
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<tbody>
<tr>
<td>01</td>
<td><strong>Probability theory:</strong> Probability: Standard definitions and concepts; Conditional Probability, Baye’s Theorem. <strong>Probability Distributions:</strong> Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. <strong>Measures of Dispersion:</strong> Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Reliability Concepts:</strong> Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. <strong>Failure Data Analysis:</strong> Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. <strong>Reliability Hazard Models:</strong> Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>System Reliability:</strong> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td><strong>Reliability Improvement:</strong> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Maintainability and Availability:</strong> 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.</td>
<td>05</td>
</tr>
<tr>
<td>06</td>
<td><strong>Failure Mode, Effects and Criticality Analysis:</strong> 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</td>
<td>05</td>
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REFERENCES:
Course Code: ILO 1013  
Course Name: Management Information System  
Credits: 03

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

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

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<tr>
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</tr>
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<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>
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<tr>
<td>05</td>
<td>Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.</td>
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REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
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<tr>
<td>ILO 1014</td>
<td>Design of Experiments</td>
<td>03</td>
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</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

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</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>
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<td></td>
<td>1.2 Typical Applications of Experimental Design</td>
<td></td>
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<tr>
<td></td>
<td>1.3 Guidelines for Designing Experiments</td>
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<td>1.4 Response Surface Methodology</td>
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<td></td>
<td><strong>Fitting Regression Models</strong></td>
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<tr>
<td></td>
<td>2.1 Linear Regression Models</td>
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<td></td>
<td>2.2 Estimation of the Parameters in Linear Regression Models</td>
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<td></td>
<td>2.3 Hypothesis Testing in Multiple Regression</td>
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<td>2.4 Confidence Intervals in Multiple Regression</td>
<td></td>
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<td>2.5 Prediction of new response observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.6 Regression model diagnostics</td>
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<td></td>
<td>2.7 Testing for lack of fit</td>
<td></td>
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<tr>
<td>02</td>
<td><strong>Two-Level Factorial Designs and Analysis</strong></td>
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<tr>
<td></td>
<td>3.1 The $2^2$ Design</td>
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<td>3.2 The $2^3$ Design</td>
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<td>3.3 The General $2^k$ Design</td>
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<td>3.4 A Single Replicate of the $2^k$ Design</td>
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<td></td>
<td>3.5 The Addition of Center Points to the $2^k$ Design,</td>
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<td>3.6 Blocking in the $2^k$ Factorial Design</td>
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<td>3.7 Split-Plot Designs</td>
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<tr>
<td>03</td>
<td><strong>Two-Level Fractional Factorial Designs and Analysis</strong></td>
<td></td>
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<td></td>
<td>4.1 The One-Half Fraction of the $2^k$ Design</td>
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<td></td>
<td>4.2 The One-Quarter Fraction of the $2^k$ Design</td>
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<tr>
<td></td>
<td>4.3 The General $2^{kp}$ Fractional Factorial Design</td>
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<td></td>
<td>4.4 Resolution III Designs</td>
<td></td>
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<td></td>
<td>4.5 Resolution IV and V Designs</td>
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<tr>
<td></td>
<td>4.6 Fractional Factorial Split-Plot Designs</td>
<td></td>
</tr>
</tbody>
</table>
### Conducting Tests

| 5.1 | Testing Logistics |
| 5.2 | Statistical aspects of conducting tests |
| 5.3 | Characteristics of good and bad data sets |
| 5.4 | Example experiments |
| 5.5 | Attribute Vs Variable data sets |

### Taguchi Approach

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

### 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
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO 1015</td>
<td>Operations Research</td>
<td>03</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Operations Research:</strong> Introduction, Structure of the Mathematical Model, Limitations of Operations Research</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Linear Programming:</strong> 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, <strong>Duality</strong>, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td><strong>Assignment Problem:</strong> 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</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Integer Programming Problem:</strong> Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td><strong>Queuing models:</strong> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</td>
<td>05</td>
</tr>
<tr>
<td>03</td>
<td><strong>Simulation:</strong> 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</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td><strong>Dynamic programming.</strong> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.</td>
<td>05</td>
</tr>
<tr>
<td>05</td>
<td><strong>Game Theory.</strong> 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.</td>
<td>05</td>
</tr>
</tbody>
</table>
Assessment:

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

REFERENCES:
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.

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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538
Course Code: ILO 1017  
Course Name: Disaster Management and Mitigation Measures  
Credits: 03

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 of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Natural Disaster and Manmade disasters:</td>
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<tr>
<td></td>
<td>2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion</td>
<td></td>
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<td></td>
<td>2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.</td>
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<tr>
<td>03</td>
<td>Disaster Management, Policy and Administration</td>
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<td></td>
<td>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.</td>
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<td></td>
<td>3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.</td>
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<tr>
<td>04</td>
<td>Institutional Framework for Disaster Management in India:</td>
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<td></td>
<td>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.</td>
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<td></td>
<td>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.</td>
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<tr>
<td>05</td>
<td>Financing Relief Measures:</td>
<td></td>
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<tr>
<td></td>
<td>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO’s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO’s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.</td>
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<tr>
<td></td>
<td>5.2 International relief aid agencies and their role in extreme events.</td>
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</table>

University of Mumbai, ME (Mechanical) Manufacturing Systems Engineering, Rev 2016  35
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:
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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:
5. ‘Disaster management & rehabilitation’ by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ILO 1018</td>
<td>Energy Audit and Management</td>
<td>03</td>
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</tbody>
</table>

**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>
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</thead>
<tbody>
<tr>
<td>02</td>
<td><strong>Energy Audit Principles:</strong> 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><strong>Energy Management and Energy Conservation in Electrical System:</strong> 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><strong>Energy Management and Energy Conservation in Thermal Systems:</strong> 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><strong>Energy Performance Assessment:</strong> 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><strong>Energy conservation in Buildings:</strong> 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:
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2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geooy Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
8. www.energymanagertraining.com
9. www.bee-india.nic.in
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Lab. Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Operation, Control and Programming of various computer controlled machines in the FMS such as CNC machine tools, Automated Storage/Retrieval (AS/RS) systems, Robots, automated assembly station etc Or Any one from the above and Case study presentation on Simulation and performance analysis of the FMS, parts flow control on Assembly station.</td>
<td>07</td>
</tr>
<tr>
<td>02</td>
<td>Study experiments on Integration aspects in computer integrated manufacturing environment. Importance of Artificial Intelligence.</td>
<td>06</td>
</tr>
</tbody>
</table>

Note- With reference to the case study based experiments/presentations on the above topics; It is desirable to have innovations. Repetition of case studies should be avoided. May be prepared from recent journal papers, books or actual visit to any Automated (Fully or partially) Manufacturing Industry

Assessment:

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Lab. Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Using live data from separate case studies and complete analysis of following topics (minimum three). Every student is expected to do individual and different three case studies from the above syllabus.</td>
<td>05</td>
</tr>
<tr>
<td>02</td>
<td>Use of modern software for complete analysis of data from experimentation or a Field / online survey questionnaire. One full report may be submitted mentioning all its objectives, methodologies, inferences etc..</td>
<td>05</td>
</tr>
<tr>
<td>03</td>
<td>Assignment based on each module</td>
<td>03</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
--- | --- | ---
MSEC201 | Sustainable Manufacturing | 04

**Objectives**
1. To Study concepts of Sustainability, Environment and Social Dimensions of Sustainability.
2. To impart knowledge of types and Sources of solid and hazardous wastes and methods of recycling.
3. To Study materials for sustainability and integrating sustainability principles.
4. To understand various conversion technology and various aspects of design environment.
5. To acquaint methods of Multi-objective decision making and Sustainability Assessment

**Outcomes:** Learner will be able to…
1. To understand the economic, technical, and societal issues involved in Sustainable manufacturing.
2. To identify Sources of solid and hazardous wastes.
3. To apply Environment Friendly choices of Materials and Processes selection.
4. To develop design for environment and analyze Environmental Standards, Legislation.
5. To apply Multi-objective decision making and Sustainability Assessment.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>01</strong></td>
<td>Sustainability: Concepts related to Sustainability, Environmental, Economic and Social Dimensions of Sustainability. Sustainable Development, The global sustainability Agenda, Green Expectations, Confronting climatic change, Wake-up Conferences, The Voice of Society, Answering the call- The Green Movement.</td>
<td>05</td>
</tr>
<tr>
<td><strong>02</strong></td>
<td>Types and sources of solid and hazardous wastes: Nature and hazard of pollutants: waste processing /segregation. Need for waste management, Waste processing, Green processing and engineering operations, incineration, Energy recovery, a life-cycle approach, which considers the costs and benefits associated with material acquisition. Transportation, production, product use, R3 and R6 cycles, Design for recycling – Eco friendly product design methods – Methods to infuse sustainability in early product design phases</td>
<td>08</td>
</tr>
<tr>
<td><strong>03</strong></td>
<td>Environment friendly choices in manufacturing and operations: Materials for Sustainability, Materials and processes selection, Materials for the future, Materials for Recycling, Control on non-renewable material usage Component toxicity and health impact, Integrating sustainability principles. Adoption of low carbon technologies - need to reduce the carbon footprint of manufacturing operations</td>
<td>10</td>
</tr>
<tr>
<td><strong>04</strong></td>
<td>Design for Environment: Conversion technologies, Innovations for reuse, bio processing technology, Energy audits, Sustainable loading on ecosystems. The concept of “Eco-innovation,” a measurable characteristic of products and processes, Product Life Cycle Assessment: Environmental analysis from raw materials to disposal, Matrices for sustainable design, industrial case studies.</td>
<td>10</td>
</tr>
</tbody>
</table>
**Assessment:**

**Internal:**
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**References:**

2. Green Management by M. Karpagam, Geetha Jaikumar; Ane Books Pvt. Ltd.
Course Code  |  Course Name  |  Credits
--- | --- | ---
MSEC202  |  Industrial Automation  |  04

**Objectives**
1. To acquaint with basic concepts of industrial automation involving pneumatic and hydraulic controls.
2. To familiarize with the elements of electro-pneumatic interface with control systems.
3. To learn about programmable logic controller.
4. To know the role of robotics in Automation

**Outcomes:** Learner will be able to…
1. Students shall be able to understand the working of automation systems and shall acquire the insight to build the automation systems.
2. Illustrates the use of PLC in Automation.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
</table>
| **01** | **Introduction to Automation**  
Automation in production system, Automation principles and strategies, Elements of Automated system, Advanced automation function, Levels of Automation, Arguments for and against automation | 04 |
| **02** | **Microcontrollers, Sensors and Transducers, Actuators**  
Overview of microcontrollers & Interfacing, Displacement, position and Proximity Sensors, Velocity and Motion Sensors, Force and Fluid Pressure Sensors, Liquid level and Flow sensors, Temperature and light Sensors, Servomotors/Steeper motors | 08 |
| **03** | **Programmable and Logic Controller**  
PLC configuration and selection  
PLC Basic components and their symbols  
Control transformers and fuses - Switches and Indicator lamps, Relays and time delay relays  
PLC Programming - Fundamentals of Ladder Programming, Ladder programming for logic gates and latching, Sequencing, counters, timers, shift register and Master & Jump control, Introduction to Supervisory control and data Aquicission | 08 |
| **04** | **Control Engineering**  
Mathematical modelling of Servo systems - Armature controlled D.C. motor, Field controlled D.C. motor  
Design of PD, PI and PID Controllers.  
Frequency Response Analysis - Frequency domain specifications for second order system, Nyquist plot  
State Space Analysis - State space representation of systems, Controllability and Observability, Transfer function from state space matrices | 09 |
| **05** | **Pneumatic and Hydraulic actuation systems**  
Mechanical and Electrical actuators.  
Pneumatic Control - Different types of valves and Actuators in Pneumatics, their applications and use of their ISO symbols, Design of Pneumatic circuits using Cascade method and Shift Register Method. (Up to 3 cylinders), Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping, Design of Pneumatic circuits using PLC Control (ladder | 15 |
programming only). Up to 2 cylinders, with applications of Timers and Counters and Concept of Flag and latching.

Hydraulic Control - Different types of valves and Actuators in Hydraulics, their applications and use of their ISO symbols, Meter in, meter out and Bleed off circuits. Sequencing circuits, Accumulators and their types. Applications of Accumulator circuits, Problems based on sizing and selection of Hydraulic components, Actuation technology in Hydraulic valves: Proportional and Servo, Hydraulics and Digital Hydraulics. Design of Electro-Hydraulic, circuits

<table>
<thead>
<tr>
<th>06</th>
<th>Robotics</th>
<th>Automation and Robotics, Robot types, anatomy and related attributes, accuracy, repeatability Trajectory planning, Robot control system and end effector, Sensors in robotics, Industrial application and future applications, Introduction to Artificial Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>09</td>
<td></td>
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</tr>
</tbody>
</table>

**Assessment:**

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

**References:**

2. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering; Pearson Education
12. Robotics : Modelling & Control – B. Siciliano
Course Code | Course Name | Credits
--- | --- | ---
MSEC203 | Advanced Quantitative Techniques | 04

Objectives
1. Familiarize the students with the use of practice oriented mathematical applications for optimization functions in an organization.
2. To understand and solve linear and nonlinear problems in industrial applications.
3. Familiarize the students with various tools of optimization, probability, statistics and simulation, as applicable in particular scenarios in industry for better management of various resources

Outcomes: Learner will be able to…
1. Illustrate the need to optimally utilize the resources in various types of industries
2. Demonstrate cost effective strategies in various applications in industry.
3. Apply and analyze mathematical optimization functions to various applications.
4. Perform exhaust gas analysis and comment on adverse implications on environment

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Decision environment, Decision making process; Optimization, search problems, Heuristics, deterministic and probabilistic situations, single and multiple persons making, Introduction to related software</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td>Linear programming problems(LPP), Big m method Two phase method Advance Topics in linear programming problems - Sensitivity analysis, Revised Simplex Method, Goal programming, Parametric Linear programming, Integer Linear programming</td>
<td>14</td>
</tr>
<tr>
<td>03</td>
<td>Introduction Nonlinear programming problems (NLPP) Unconstrained Nonlinear Algorithm, Search and Gradient method Constrained Nonlinear Algorithm - Geometric Programming, Separable Programming, Quadratic programming, Stochastic Programming</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>Dynamic (Multistage) programming and its applications in various fields</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Decision Theory Decision under risk Decision under uncertainty Decision tree for decision making, Bayesian approach in decision making</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Queuing Theory - Single channel queuing model (with Poisson arrival and Exponential service times), Poisson-Exponential multiple channel queuing model, Poisson Arrival and Earl ing service distribution Monte Carlo simulation</td>
<td>08</td>
</tr>
</tbody>
</table>
Assessment:

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4. Only Four questions need to be solved.

References:

5. Kapoor R. Computer assisted decision models Tata McGraw Hill
### Objectives
1. Understand what supply chain is and how it works.
2. An understanding of the primary differences between logistics and supply chain management.
3. An understanding of the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain.
4. An understanding of the management components of supply chain management.
5. An understanding of the tools and techniques useful in implementing supply chain management.
6. Understand how supply chain strategy can provide competitive advantage for organization.

### Outcomes:
Learner will be able to…
1. Analyze the manufacturing operations of a firm.
2. Apply sales and operations planning, MRP and lean manufacturing concepts.
3. Apply logistics and purchasing concepts to improve supply chain operations.
4. Apply quality management tools for process improvement.

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<tr>
<td>01</td>
<td><strong>Introduction:</strong> Evolution of SCM, Understanding Supply Chain. Historical developments in supply chain management. Issues in SCM, linkages within the value chain, strategic Supply Chain Management (SCM) decision phases, and Scope of Logistics, philosophy and concept work of logistics. Mission of logistics management, logistics &amp; competitive strategy. Service-driven logistics systems.</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Supply Chain performance:</strong> Customer driven strategies in production &amp; distribution systems. Customer focus in SCM, management of supply sources,. Drivers &amp; obstacles, Different performance measures. Different multi-objective decision making and application of AHP. Measuring logistics costs &amp; performance.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Planning Demand &amp; Supply in SC:</strong> Demand forecasting, Aggregate Planning, Planning &amp; managing inventories in SC, Distribution network designs. Factors influencing network designs, distribution networks in practice frame work for network design decision. Network design in uncertain environment.</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td><strong>Information Systems in Supply Chain:</strong> IT enabled SC, Best practices &amp; benchmarking for SC, towards Green SC, towards World class SCM. Role of IT in Logistics management, the role of information in the virtual supply chain.</td>
<td>08</td>
</tr>
</tbody>
</table>
Leading edge logistics, IT application in freight logistics. 
Case studies from the literature & practice. 
Basic familiarity with mathematical modelling & optimization.

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4. Only Four questions need to be solved.

References:

2. R.P. Mohanty, S.G. Deshmukh, Essentials of Supply Chain management, Phoenix publishing House Pvt Ltd.
3. Martin Christopher, Logistics and Supply Chain Management, Pitman Publishing.
5. Michael Hugos, Essentials of Supply Chain Management, John Wiley and Sons
6. S.K. Bhattacharya , Logistics Management, Pearson Publication
7. R.P. Mohanty, S.G. Deshmukh, Supply Chain management, Theories and Pratices , biztantra
<table>
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<tr>
<th>Module</th>
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</table>
| 01     | **Business Intelligence overview:**  
Introduction to Data, Information, and Knowledge,  
Introduction to Business Intelligence and Business Models, BI  
Definitions & Concepts, Business Applications of BI, BI system components.  
Historical review - Study of Information Technology resources such as Database systems, enterprise systems, and networks explained in their role of supporting decision makers.  
Special attention given to hands-on-experience in team projects for developing and using Business Intelligence.  
Ethical, legal, and behavioural issues of conducting Business Intelligence | 08 |
| 02     | **Knowledge Management:**  
Collaborative Business Intelligence: Integrating BI and KM.  
Taking lessons from KM to influence business intelligence, Data quality. Technological Support for Strategic Management in the Knowledge Based Economy, People centric BI and KM.  
Relationship and Integration of KM Content, KM as an Intelligence Tool using MS office/ MS SharePoint /SAP | 08 |
| 03     | **Capture the business and technical requirements for Business Intelligence solution architecture.**  
The stages and requirements of a Business Intelligence project lifecycle. Implementation of a Business Intelligence development project.  
Assess and design a Business Intelligence infrastructure.  
Describe and plan Business Intelligence operations and their management. Managing Data Archiving. Planning and implementing data archiving in a BI solution. | 08 |
| 04     | **Planning a Business Intelligence Project**  
Determining Business Intelligence Requirements  
Revising and Updating a Business Intelligence. Intelligence development requirements and implement a Business Intelligence development project.  
Manage a Business Intelligence development project.  
Determine effective data management processes. | 08 |
Designing Business Intelligence Infrastructure
How to identify infrastructure requirements for a Business Intelligence solution, and how to design an effective infrastructure to provide the required levels of scalability and availability. Evaluating Software Requirements.

Managing Business Intelligence Operations
Overview of Business Intelligence Operations, Managing Maintenance and Operations Tasks, Managing Data Archiving, Planning the Operations Solution, Evaluating Operational Costs and Risks

The online analytical processing (OLAP)
Extract, transport, Data Migration and ETL (Extract, Transform, and Load). Reporting technologies. Foundational understanding of Web-based architecture

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<tr>
<td>01</td>
<td><strong>Rapid Prototyping</strong>&lt;br&gt;Historical Development, Prototypes ,Need for Prototypes and Types of Prototypes Applications: Design, Planning, Manufacturing and Tooling Applications: Automotive, Aerospace, Jewelry, Bio-Medical and custom products, Fundamentals of Rapid Prototyping technologies and Process</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td><strong>Subsystems of RP Machine</strong>&lt;br&gt;Subsystems of RP machine, Optical System, Mechanical systems, Scanning System, Control System: Signal Flow, 3D Model to RP Prototype, Computer Interfacing hardware, DAQs -3D content creation: Modeling Software’s (Auto-CAD, PROE, CATIA, and IDEAs etc.) Preprocessing: Slicing and Scan Path Generation Algorithms, Data Conversion and Transmission, File Formats, IGES, STL, AMF , 3DF Post-processing – The Need, Types and applications</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>Liquid Based Rapid Prototyping Systems</strong>&lt;br&gt;Materials, Stereo lithography, Solid Ground Curing, Solid Object UV (Ultra-Violet).</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td><strong>Solid Based Rapid Prototyping Systems</strong>&lt;br&gt;Materials, LOM (Laminated Object Manufacturing) System, FDM (Fuse Deposition Modeling) System, Multi-Jet Modeling (MJM) System Model Maker and Pattern Master Shape Deposition Manufacturing Process</td>
<td>06</td>
</tr>
</tbody>
</table>

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

1. Understand the relevance and basics of Rapid Prototyping, categories of Prototyping, and advances in 3D printing technology.
2. Understand how to work in team to design the parts and manufacturing by rapid prototyping and tooling method
Assessment:

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</thead>
<tbody>
<tr>
<td>MSEDLO 2024</td>
<td>Micro &amp; Nano Manufacturing System</td>
<td>04</td>
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</tbody>
</table>

**Objectives**

1. The course aims to provide basic understanding of micromachining processes
2. Students should learn the design and fabrication aspects of micro / nano-manufacturing, by using computer-aided-design tools to design and draw their own microstructures.

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

1. Calculate power requirements and process performance in laser micromachining
2. Be aware of the hazards involved in dealing with toxic/dangerous materials
3. Develop and present a conceptual design solution to a precision machine operating in the micro and nano range
4. Be aware of techniques for advanced nano polymer materials processing, nano materials, and coatings

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<tr>
<td>01</td>
<td><strong>Scope of Nano Technology:</strong> Nano technology Concepts and Applications Micro- and Nanofabrication, Nano technology in India Scope for Micro fabrication, Rise Nano technology Fields Commercialization Issues of Micro-Nano Technology</td>
<td>06</td>
</tr>
<tr>
<td>02</td>
<td><strong>Micro fabrication:</strong> Mechanical Micromachining, Physical Fabrication Methods, Lithography, Processing Setup, Nano Lithography &amp; Manipulation, Precision Micro-and Nano grinding , Use of Spectrometers &amp; Microscopes</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td><strong>Innovative Applications on Present Devices:</strong> Nano chips, Nanotubes and Nanowires, Integration of chip sand microprocessors. Technology Support, Meeting Social Needs</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td><strong>Nano Design &amp; CAD:</strong> Computer Aided Nano Design, VLSI product detailing Finite Element Analysis of Microstructures, 3-D Molecular Modeling</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Acceptability of Nano Workmanship:</strong> Nano to millimeter Integration Atomic Scale Precision &amp; Control, Promising Nano-centered Future</td>
<td>10</td>
</tr>
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**References:**

1. ASM handbook on machining
5. M. Kahrizi, “Micromachining techniques for fabrication of micro, Nano structures”
**Course Code**  | **Course Name** | **Credits**  
---|---|---
ILO 2021 | Project Management | 03

**Objectives:**
1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

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

<table>
<thead>
<tr>
<th>Module</th>
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<th>Hrs</th>
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</thead>
</table>
| 01 | **Project Management Foundation:**
Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). | 5 |
| 02 | **Initiating Projects:**
How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics. | 6 |
| 03 | **Project Planning and Scheduling:**
Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). | 8 |
| 04 | **Planning Projects:**
Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.
| 05 | **5.1 Executing Projects:**
Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.
Team management, communication and project meetings. | 8 |
| 05 | **5.2 Monitoring and Controlling Projects:**
Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. | 8 |
| 05 | **5.3 Project Contracting**
Project procurement management, contracting and outsourcing. | |
| 06 | **6.1 Project Leadership and Ethics:**
Introduction to project leadership, ethics in projects.
Multicultural and virtual projects. | |
| 06 | **6.2 Closing the Project:**
Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | 6 |
Assessment:
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References:
1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
4. Gopalan, Project Management, Wiley India
### Finance Management

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO 2022</td>
<td>Finance Management</td>
<td>03</td>
</tr>
</tbody>
</table>

#### Objectives:
1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

#### Outcomes:
1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

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

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<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

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<tr>
<td>03</td>
<td>Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises</td>
<td>05</td>
</tr>
<tr>
<td>04</td>
<td>Indian Environment for Entrepreneurship: key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business</td>
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References:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in
### Course Details

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<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILO2024</td>
<td>Human Resource Management</td>
<td>03</td>
</tr>
</tbody>
</table>

#### 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.

#### Module | Detailed Contents | Hrs
--- | --- | ---
01 | **Introduction to HR**
- Human Resource Management - Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.
- Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 5

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

03 | **Organizational Structure & Design**
- Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.
- Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.
- Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 6

04 | **Human Resource Planning**
- Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.
- Training & Development: Identification of Training Needs, Training Methods | 5
Emerging Trends in HR
- Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment
- Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.

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

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

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

Assessment:
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.

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<tbody>
<tr>
<td>ILO2025</td>
<td>Professional Ethics and Corporate Social Responsibility (CSR)</td>
<td>03</td>
</tr>
</tbody>
</table>

**Objectives:**
1. To understand professional ethics in business
2. To recognized 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><strong>Professional Ethics and Business:</strong> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business</td>
<td>04</td>
</tr>
<tr>
<td>02</td>
<td><strong>Professional Ethics in the Marketplace:</strong> Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy <strong>Professional Ethics and the Environment:</strong> 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><strong>Professional Ethics of Consumer Protection:</strong> Markets and Consumer Protection; Contract View of Business Firm’s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy <strong>Professional Ethics of Job Discrimination:</strong> Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.</td>
<td>06</td>
</tr>
<tr>
<td>04</td>
<td><strong>Introduction to Corporate Social Responsibility:</strong> 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>
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<tr>
<td>05</td>
<td><strong>Corporate Social Responsibility:</strong> 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><strong>Corporate Social Responsibility in Globalizing India:</strong> 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>
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</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.
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>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction and Basic Research Concepts</td>
<td>09</td>
</tr>
<tr>
<td></td>
<td>1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</td>
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<tr>
<td></td>
<td>1.2 Need of Research in Business and Social Sciences</td>
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<td>1.3 Objectives of Research</td>
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<td>1.4 Issues and Problems in Research</td>
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<td>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</td>
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<tr>
<td>02</td>
<td>Types of Research</td>
<td>07</td>
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<td></td>
<td>2.1 Basic Research</td>
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<td>2.2 Applied Research</td>
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<td></td>
<td>2.3 Descriptive Research</td>
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<td></td>
<td>2.4 Analytical Research</td>
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<td></td>
<td>2.5 Empirical Research</td>
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<td></td>
<td>2.6 Qualitative and Quantitative Approaches</td>
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<tr>
<td>03</td>
<td>Research Design and Sample Design</td>
<td>07</td>
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<tr>
<td></td>
<td>3.1 Research Design – Meaning, Types and Significance</td>
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<td></td>
<td>3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors</td>
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<tr>
<td>04</td>
<td>Research Methodology</td>
<td>08</td>
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<tr>
<td></td>
<td>4.1 Meaning of Research Methodology</td>
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<tr>
<td></td>
<td>b. Formulation of Research Problem</td>
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<td></td>
<td>c. Review of Literature</td>
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<td></td>
<td>d. Formulation of Hypothesis</td>
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<td>e. Formulation of research Design</td>
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<td>f. Sample Design</td>
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<td></td>
<td>g. Data Collection</td>
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<td></td>
<td>h. Data Analysis</td>
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<tr>
<td></td>
<td>i. Hypothesis testing and Interpretation of Data</td>
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<td></td>
<td>j. Preparation of Research Report</td>
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<tr>
<td>05</td>
<td>Formulating Research Problem</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</td>
<td></td>
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<tr>
<td>06</td>
<td>Outcome of Research</td>
<td>04</td>
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<tr>
<td></td>
<td>6.1 Preparation of the report on conclusion reached</td>
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<td></td>
<td>6.2 Validity Testing &amp; Ethical Issues</td>
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<td></td>
<td>6.3 Suggestions and Recommendation</td>
<td></td>
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1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four questions need to be solved.

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

### Outcomes:
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>
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</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.</td>
<td>05</td>
</tr>
<tr>
<td></td>
<td>Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement</td>
<td>07</td>
</tr>
<tr>
<td></td>
<td>Indian Scenario of IPR: 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></td>
</tr>
<tr>
<td>03</td>
<td>Emerging Issues in IPR: 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>Basics of Patents: 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>Patent Rules: 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>
<tr>
<td></td>
<td>Patent databases: Important websites, Searching international databases</td>
<td></td>
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4. Only Four questions need to be solved.

References:
## Course: Digital Business Management

**Course Code:** ILO 2028  
**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>
</table>
| 1      | **Introduction to Digital Business**- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts  
**Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)  
Opportunities and Challenges in Digital Business, | 09 |
| 2      | **Overview of E-Commerce**  
**E-Commerce**- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement  
Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing  
EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | 06 |
| 3      | **Digital Business Support services:** ERP as e-business backbone, knowledge  
Tope Apps, Information and referral system  
**Application Development:** Building Digital business Applications and Infrastructure | 06 |
| 4      | **Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business  
| 6      | **Materializing e-business: From Idea to Realization**-Business plan preparation  
Case Studies and presentations | 08 |
Assessment:

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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
Course Code | Course Name | Credits
--- | --- | ---
ILO2029 | Environmental Management | 03

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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<tbody>
<tr>
<td>01</td>
<td>Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/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>
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Assessment:
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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
<table>
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<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Lab. Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simulation of basic hydraulic, pneumatic and electric and combination circuits using software like automationstudio--etc</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Design and Testing of hydraulic, Pneumatic, electro pneumatic and PLC circuits.</td>
<td>04</td>
</tr>
<tr>
<td>3</td>
<td>Simulation of Nyquist plots and State-space representation.</td>
<td>04</td>
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</tbody>
</table>

**Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed content</th>
<th>Lab. Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exercises on LPP Software, AHP Software’s &amp; others.</td>
<td>05</td>
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<tr>
<td>2</td>
<td>Exposure to other OR &amp; Simulation software.</td>
<td>04</td>
</tr>
<tr>
<td>3</td>
<td>Live case studies / Assignments.</td>
<td>04</td>
</tr>
</tbody>
</table>

Assessment:

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
Guidelines for Seminar

- Seminar should be based on thrust areas in Mechanical Engineering (Manufacturing Systems 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
Guidelines for Dissertation
- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

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

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

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

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