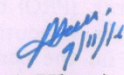


**UNIVERSITY OF MUMBAI**  
**No. UG/140f 2016-17**

**CIRCULAR:-**

A reference is invited to the syllabi relating to the Master of Engineering (Mechanical) Machine design degree course vide this office Circular No.UG/151 of 2012-13, dated 20<sup>th</sup> 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 8<sup>th</sup> July, 2016 has been accepted by the Academic Council at its meeting held on 14<sup>th</sup> July, 2016 vide item No. 4.32 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) Machine Design (Sem. I & II), which is available on the University's web site ([www.mu.ac.in](http://www.mu.ac.in)) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032  
9<sup>th</sup> November, 2016

  
(Dr.M.A.Khan)  
REGISTRAR

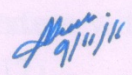
To,  
The Principals of affiliated Colleges in Engineering.

**A.C/ 4.32/14/07/2016.**

No. UG/140A of 2016 MUMBAI-400 032 9<sup>th</sup> 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.

  
(Dr.M.A.Khan)  
REGISTRAR

... PTO

**UNIVERSITY OF MUMBAI**



**Revised Syllabus for the M. E. Program**

**Program: M. E. (Mechanical)**

**MACHINE DESIGN**

**(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 (Machine Design)  
Mumbai University  
(With Effect from 2016-2017)**

**Semester I**

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned						
		Theory	Pract	Theory	Pract	Total				
MDC101	Mechanical Vibration	04	--	04	--	04				
MDC102	Analysis and Synthesis of Mechanisms	04	--	04	--	04				
MDC103	Advanced Stress Analysis	04	--	04	--	04				
MDDLO 101X	Department Level Optional Course I	04	--	04	--	04				
ILO101X	Institute Level Optional Course I	03	--	03	--	03				
MDL101	Laboratory I - Finite Element Analysis	--	02	--	01	01				
MDL102	Laboratory II - Vibration Measurement and Analysis	--	02	--	01	01				
<b>Total</b>		<b>19</b>	<b>04</b>	<b>19</b>	<b>02</b>	<b>21</b>				
Course Code	Course Name	Examination Scheme								
		Theory					Exam Duration (Hrs)	Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam					
		Test1	Test2	Avg						
MDC101	Mechanical Vibration	20	20	20	80	03	--	--	100	
MDC102	Analysis and Synthesis of Mechanisms	20	20	20	80	03	--	--	100	
MDC103	Advanced Stress Analysis	20	20	20	80	03	--	--	100	
MDDLO 101X	Department Level Optional Course I	20	20	20	80	03	--	--	100	
ILO101X	Institute Level Optional Course I	20	20	20	80	03	--	--	100	
MDL101	Laboratory I - Finite Element Analysis	--	--	--	--	--	25	25	50	
MDL102	Laboratory II - Vibration Measurement and Analysis	--	--	--	--	--	25	25	50	
<b>Total</b>		<b>100</b>	<b>100</b>	<b>100</b>	<b>400</b>		<b>50</b>	<b>50</b>	<b>600</b>	

<b>Course Code</b>	<b>Department Level Optional Course I</b>	<b>Course Code</b>	<b>Institute Level Optional Course I</b>
MDDL01011	Process Equipment Design	ILO1011	Product Lifecycle Management
MDDL01012	Rapid Prototyping and Tooling	ILO1012	Reliability Engineering
MDDL01013	Fracture Mechanics	ILO1013	Management Information System
MDDL01014	Composite Materials	ILO1014	Design of Experiments
		ILO1015	Operation Research
		ILO1016	Cyber Security and Laws
		ILO1017	Disaster Management and Mitigation Measures
		ILO1018	Energy Audit and Management

## Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned						
		Theory	Pract	Theory	Pract	Total				
MDC201	System Modeling & Analysis	04	--	04	--	04				
MDC202	Optimization	04	--	04	--	04				
MDC203	Machine Tool Design	04	--	04	--	04				
MDDLO 202X	Department Level Optional Course II	04	--	04	--	04				
ILO202X	Institute Level Optional Course II	03	--	03	--	03				
MDL201	Laboratory III - CAD/CAM/CIM	--	02	--	01	01				
MDL202	Laboratory IV - Measurement & Virtual Instrumentation	--	02	--	01	01				
<b>Total</b>		<b>19</b>	<b>04</b>	<b>19</b>	<b>02</b>	<b>21</b>				
Course Code	Course Name	Examination Scheme								
		Theory					Exam Duration (Hrs)	Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam					
		Test1	Test 2	Avg						
MDC201	System Modeling & Analysis	20	20	20	80	03	--	--	100	
MDC202	Optimization	20	20	20	80	03	--	--	100	
MDC203	Machine Tool Design	20	20	20	80	03	--	--	100	
MDDLO 202X	Department Level Optional Course II	20	20	20	80	03	--	--	100	
ILO202X	Institute Level Optional Course II	20	20	20	80	03	--	--	100	
MDL201	Laboratory III - CAD/CAM/CIM	--	--	--	--	--	25	25	50	
MDL202	Laboratory IV - Measurement & Virtual Instrumentation	--	--	--	--	--	25	25	50	
<b>Total</b>			<b>100</b>	<b>100</b>	<b>400</b>		<b>50</b>	<b>50</b>	<b>600</b>	

Course Code	Department Level Optional Course II	Course Code	Institute Level Optional Course II
MDDLO2021	Theory of Plates	ILO2021	Project Management
MDDLO2022	Micro Electro Mechanical Systems	ILO2022	Finance Management
MDDLO2023	Smart Materials	ILO2023	Entrepreneurship Development and Management
MDDLO2024	Tribology	ILO2024	Human Resource Management
		ILO2025	Professional Ethics and CSR
		ILO2026	Research Methodology
		ILO2027	IPR and Patenting
		ILO2028	Digital Business Management
		ILO2029	Environmental Management

### Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract	Theory	Pract	Total			
MDS301	Seminar	--	06	--	03	03			
MDD301	Dessertation I	--	24	--	12	12			
<b>Total</b>		--	<b>30</b>	--	<b>15</b>	<b>15</b>			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test 2	Avg					
MDS301	Seminar*	--	--	--	--	50	50	100	
MDD301	Dessertation I	--	--	--	--	100	--	100	
<b>Total</b>		--	--	--	--	<b>150</b>	<b>50</b>	<b>200</b>	

### Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract	Theory	Pract/Oral	Total			
MDD401	Dessertation II	--	30	--	15	15			
<b>Total</b>		--	<b>30</b>	--	<b>15</b>	<b>15</b>			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test 2	Avg					
MDD401	DessertationII*	--	--	--	--	100	100	200	
<b>Total</b>		--	--	--	--	<b>100</b>	<b>100</b>	<b>200</b>	

**\*Seminar of Semester III and Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners**

**Note-** The Contact Hours for the calculation of load of teacher are as follows  
 Seminar - 01 Hour / week / student  
 Project I and II - 02 Hour / week / student



Course Code	Course Name	Credits
<b>MDC 101</b>	<b>Mechanical Vibration</b>	<b>04</b>

### Objectives

1. To study the Multi-degree of freedom system.
2. To study different vibration measurement and control methods, and required instruments.
3. To study the basic concepts of nonlinear vibrations.
4. To study various methods of vibration analysis for detecting machinery malfunction.

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

1. Develop a mathematical model for multi-degree of freedom system.
2. To identify and use vibration measuring instruments.
3. To apply various vibration control methods.
4. To detect machinery malfunction using vibration analysis.

Module	Detailed Contents	Hrs.
01	<b>Multi-Degree of Freedom System</b> Free Vibration Equation of motion, Influence Coefficients (Stiffness and Flexibility), Generalized Coordinates, and Coordinate Coupling. Lagrangian and Hamilton Equations, Matrix Method, Eigen value and Eigen Vector Method.	10
02	<b>Vibration Measurement</b> Basic signal attributes, Vibration measuring sensors (Displacement, Velocity, and Acceleration), Piezoelectric Accelerometers, Method for Calibrating Accelerometer, Basic Process of Digital Frequency Analyzer, Digital Analyzer operating principles, Measurement of phase, Phase fundamentals, Comparing two waveforms using reference, Cross Channel phase analysis, Electronic Filters, Time and orbital domain, Time and frequency domains, Evaluation of vibration severity, ISO standards: ISO 10816 and ISO 7919	08
03	<b>Modal Analysis</b> Introduction, Free vibration response using modal analysis, Forced vibration response using modal analysis, Experimental modal analysis: Necessary equipment, signal processing, Measurement of mode shapes, Introduction to damage detection in structures using changes in modal frequency and mode shapes	08
04	<b>Vibration Control</b> Conventional Methods: By Mass/Inertia, Stiffness, Damping (Vibration Isolation Principles). Dynamic vibration absorbers. Introduction to Semi-Active and Active vibration Control	08
05	<b>Non-Linear Vibrations</b> Basics of non-linear vibration, Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane techniques, Duffing's equation, Jump phenomenon, Limit cycle, Perturbation method.	08
06	<b>Vibration Analysis for Machinery Malfunction</b> Analysis of machinery vibration problems, Methodology of vibration analysis: Condition/vibration monitoring data collection, Trending of data, Time wave form analysis, Signature analysis, Absolute Phase analysis and cross channel phase analysis, Orbit analysis. Root Cause Analysis. Methodology of diagnosis of unbalance, misalignment and antifriction bearing defects. Frequency calculation and their significance in signature analysis of antifriction bearing, Mechanical Looseness, diagnosis of foundation problem	10

## **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. S.S. Rao, Addison, "Mechanical Vibrations", Wesley Publishing Co., 1990.
2. Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition.
3. W.T. Thomson, "Theory of Vibrations with Applications", CBS Publishers, Delhi, 2003.
4. Asok Kumar Mallik, "Principles of Vibration Control", Affiliated East-West Press.
5. A. Devies, "Hand Book of Condition Monitoring: Techniques and Methodology", Springer
6. B.K.N. Rao, "Handbook of Condition Monitoring", Elsevier
7. Steve Goldman, "Vibration Spectrum Analysis: A Practical Approach", Industrial Press Inc.
8. Paresh Girdhar and Cornelius Scheffer, "Practical Machinery Vibration Analysis and Predictive Maintenance", Elsevier
9. R. Keith Mobley, "An Introduction to Predictive Maintenance", Butterworth-Heinemann
10. Robert B. McMillan "Rotating Machinery: Practical Solutions to Unbalance and Misalignment", Fairmont Press
11. Ron Barroon, "Engineering Condition Monitoring Practice, Methodology and Applications", Pearson Education
12. Kenneth G. McConnell and Paulo S. Varoto , "Vibration Testing: Theory and Practice", John Wiley and Sons, Inc.

Course Code	Course Name	Credits
<b>MDC102</b>	<b>Analysis and Synthesis of Mechanisms</b>	<b>04</b>

### Objectives

1. To study basic concepts of analysis and synthesis of mechanisms.
2. To study the graphical and analytical techniques commonly used in the synthesis of mechanisms.
3. To study the geometric and algebraic methods related to linkage synthesis

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

1. Apply theoretical knowledge of kinematics in the analysis and synthesis of mechanisms
2. Develop analytical equations describing the relative position, velocity and acceleration of all moving links.
3. Apply geometric and algebraic methods in linkage synthesis.

Module	Detailed Contents	Hrs.
01	<b>Basics of Mechanism:</b> Rigid body, Kinematic pairs, Lower pairs connections, Higher pair connections, Kinematic chain, Mechanism, Four bar mechanism, Slider crank mechanism, Transmission, deviation and pressure angles, Equivalent mechanisms.	06
02	<b>Type Synthesis, Number Synthesis, Dimensional Synthesis</b> Type synthesis, Number synthesis, Dimensional synthesis, Accuracy points, Spacing of accuracy points, Chebyshev polynomials.	10
03	<b>Four Bar Coupler Point Curve:</b> Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem.	08
04	<b>The Euler Savary Equation and Cubic of Stationary Curvature:</b> The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.	08
05	<b>Linkage Synthesis with Three Accuracy Points (Geometric Methods):</b> Concept of poles, relative poles, pole triangle of four bar and slider crank mechanism. Application in position generation, function generation problems. <b>Linkage Synthesis with Four Accuracy Points (Geometric Methods):</b> Concept of opposite pole quadrilateral, Center point curve, Circle point curve, Application in position generation problems.	10
06	<b>Linkage Synthesis with Three Accuracy Points (Algebraic Method)</b> Fredeinstain displacement equation of four bar linkage for three accuracy points, Crank-follower linkage synthesis angular velocities and acceleration. <b>Linkage Synthesis with Three Accuracy Points:</b> Complex Number Method.	10

### 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. Rudolf Beyer, “The Kinematic Synthesis of Mechanisms”, Chapman & Hall
2. Asok Kumar Malik, Amitabh Ghosh, “Kinematic Analysis and Synthesis of Mechanism”
3. Deh Chang Tao, “Applied Linkage Synthesis”, Addison-Wesley Pub. Co.
4. Richard Scheunemann Hartenberg and Jacques Denavit, “Kinematic Synthesis of Linkages”, McGraw-Hill
5. Delbert Tesar, “Graphical Procedures for Kinematic Synthesis of Mechanism”, University of Florida

Course Code	Course Name	Credits
<b>MDC103</b>	<b>Advanced Stress Analysis</b>	<b>04</b>

### Objectives

1. To study different types of stresses and strains induced in the mechanical components due to external loads in three dimensions.
2. To study the elastic behavior of different materials in three dimensions.
3. To study different types of electrical strain gauges.
4. To study different factors affecting failures of materials.

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

1. Demonstrate knowledge about various types of loading and stresses induced in three dimensions.
2. Develop the Stress Strain relationship for different types of materials.
3. Apply the knowledge of strain gauges for measuring strain in practical applications.
4. Apply the knowledge different factors of failure for better design of mechanical components.

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Analysis of stress in three dimensions:</b> Stress at a point – components of stress; Principal stresses; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress, Hydrostatic and Deviatoric Stress Tensors Mohr's Circle for 2D and 3D stress problem.	12
<b>02</b>	<b>Analysis of strain:</b> Strain at a point – Components of strain; Differential equations of equilibrium; Conditions of compatibility, Hydrostatic and Deviatoric Strain Tensors, Mohr's Circle for 2D and 3D strain problem.	10
<b>03</b>	<b>Stress Strain relationship:</b> Generalized Hooke's law, Elastic behavior for different materials (Isotropic, Orthotropic and Anisotropic).	08
<b>04</b>	<b>Electrical Strain Gauges:</b> Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators. Load cell and its types. Introduction to Recent Trends in Strain Measurement	08
<b>05</b>	<b>Fatigue and Fracture:</b> Introduction to fatigue and fracture mechanics of ductile and brittle fractures mechanism of fatigue failure. Factors affecting fatigue. Methods of improving fatigue strength. Cumulative damage theories. Linear elastic fracture mechanics. Finite life, infinite life, design of machine components, Fracture toughness, Crack growth studies	08
<b>06</b>	<b>Environmental considerations in design:</b> Corrosion, corrosion under stress, fretting corrosion and effects of other chemicals. Methods of improving corrosion resistance.	06

## **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. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K.,
2. "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
3. M. Ameen, "Computational Elasticity", Narosa Publishing House.
4. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., New York, 1998.
5. Cook and Young, "Advanced Mechanics of Materials", Prentice Hall.
6. Richard G. Budynas, "Advanced Strength and Applied Stress Analysis", McGraw Hill.
7. Boresi, Schmidt, "Advanced Mechanics of Materials", Sidebottom, Willey.
8. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.
9. Timoshenko, "Advanced Strength of Materials, Vol. 1, 2", CBS.
10. T.L. Anderson, "Fracture Mechanics – Fundamentals and Applications" CRC Press

Course Code	Course Name	Credits
<b>MDDL0 1011</b>	<b>Process Equipment Design</b>	<b>04</b>

### Objectives

1. To study the fundamentals and codes required for designing process equipments.
2. To study the process of designing the process equipment using codes.
3. To study testing and inspection techniques related to process equipments

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

1. Apply methodology of process equipment design.
2. Design and develop pressure vessels for the given applications.
3. Apply testing and inspection techniques on the process equipments.

Module	Detailed Contents	Hrs.
01	<p><b>General Requirements</b> Basic considerations in process equipment design; general design procedure of process equipment design; Terminology used in pressure vessel design: Design pressures, Design temperatures, Design stresses, Design Loading such as wind load, temperature load, Dead load, Maximum allowable stress values, Minimum shell thickness, Welded joint efficiency and category, Corrosion allowance, Minimum design metal temperature (MDMT), Maximum allowable working pressure, Test pressure, Weight estimation of vessel, Development of pressure vessel construction code: Study of ASME section VIII Div. –I; Selection of material and its properties by using ASME section II for ferrous materials, Importance of codes and standards and their applications, Stress categories and stress</p>	08
02	<p><b>Design of Pressure Vessels</b> Types of pressure vessels; Types of head or end closure; Complete design as per ASME code of cylindrical and spherical shells: Pressure vessel subjected to internal pressure; Pressure vessel subjected to External pressure: Design of various end closures, Design of flanged joints, Design of opening such as nozzle, manhole etc., Gasket selection, Design of Tall tower; Determination of wind load and seismic load; Determination of period of vibration; Determination of deflection of tower and elastic instability</p>	10
03	<p><b>Vessel Supports</b> Introduction and types of vessel support; Design of saddle support; Design of lug supports; Design of leg supports; Design of skirt support; Design of support components: Base plate, Skirt bearing plate, Anchor bolts</p>	10
04	<p><b>Design of Storage Tanks</b> Introduction to API code; Types of storage tanks for storing volatile and non volatile fluid etc; Types of roofs used in storage vessels; Complete API design of storage tank; Calculation of shell thickness by one foot method and variable design point method; Shell attachment design; Wind girder design; Design of rectangular tank</p>	10
05	<p><b>Heat Exchangers</b> Introduction to TEMA code; Classification of TEMA heat exchangers; Nomenclature of heat exchanger components: Tube and tube bundle, Tube sheet, Tube pattern, Tube length, Baffle etc; Calculation of effective shell side and tube side design pressure; Study of various types of jacket such as half pipe, limphet coil.</p> <p><b>Agitator</b> Types of impellers; General procedure of choice of impeller type and speeds; Design of agitator shaft: Calculation of shaft diameter, Bearing load calculation, Calculation of critical speed, Calculation of deflections</p>	10

<b>06</b>	<b>Testing and inspection techniques</b> Brief introduction :Standard hydrotostatic test;Standard pneumatic test;Post weld heat treatment;Radiographic examination; Process flow diagram;Process and instrumentation diagram	04
-----------	---	----

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination\*:**

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

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

**\*Use ASME codes, API code and TEMA code is permissible in the end semester examination**

#### **References:**

1. Pressure vessel Design Manual: Dennis Moss
2. Browell and Young, "Process Equipment Design:", John Wiley
3. Pressure Vessel Design Handbook: Henry H Bednar
4. Pressure Vessel Handbook :Eugene F.Megyesy
5. Guidebook for the Design of ASME section VIII Pressure Vessels by James R. Farr and Maan H.Jawad
6. Standard Codes such as: ASME SEC-VIII, Div I & II; Section II part A, Part D; ASTM; API; TEMA..



Course Code	Course Name	Credits
<b>MDDL0 1012</b>	<b>Rapid Prototyping and Tooling<sup>s</sup></b>	<b>04</b>

### Objectives

1. To study the fundamentals of rapid prototyping and tooling technologies.
2. To study basic concepts of reverse engineering and their application in product development.
3. To study 3D Modeling Software.

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

1. Select proper rapid prototyping and reverse engineering techniques for specific technical applications.
2. Select an appropriate material and tools to develop a given product using rapid prototyping machine.
3. Develop a 3D model of a product using the software

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Rapid Prototyping</b> <ul style="list-style-type: none"> <li>• Historical Development</li> <li>• Applications: Design, Planning, Manufacturing and Tooling</li> <li>• Applications: Automotive, Jewelry, Coin and Bio-Medical</li> <li>• Fundamentals of Rapid Prototyping, Design Process</li> <li>• Rapid Prototyping Process Chain</li> </ul>	08
<b>02</b>	<b>Subsystems of RP Machine</b> <ul style="list-style-type: none"> <li>• Subsystems of RP achine</li> </ul> o Optical System <ul style="list-style-type: none"> <li>o Mechanical Scanning System</li> <li>o Computer Interfacing hardware, DAQs o Signal Flow, 3D Model to RP Prototype</li> </ul> <ul style="list-style-type: none"> <li>• Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.)</li> <li>• Slicing and Scan Path Generation Algorithms</li> <li>• Data Conversion and Transmission</li> <li>• File Formats, IGES, STL</li> <li>• Preprocessing and Post-processing</li> </ul>	10
<b>03</b>	<b>Liquid Based Rapid Prototyping Systems</b> <ul style="list-style-type: none"> <li>• Materials</li> <li>• Stereolithography</li> <li>• Solid Ground Curing</li> <li>• Solid Object UV (Ultra-Violet) Printer</li> <li>• Two Laser System</li> <li>• Micro-stereolithography.</li> </ul>	10
<b>04</b>	<b>Solid Based Rapid Prototyping Systems</b> <ul style="list-style-type: none"> <li>• Materials</li> <li>• LOM (Laminated Object Manufacturing) System</li> <li>• FDM (Fuse Deposition Modeling) System</li> <li>• Multi-Jet Modeling (MJM) System</li> <li>• Model Maker and Pattern Master</li> <li>• Shape Deposition Manufacturing Process</li> </ul>	08

<b>05</b>	<p><b>Powder Based Rapid Prototyping Systems</b></p> <ul style="list-style-type: none"> <li>• Materials</li> <li>• SLS (Selective Laser Sintering)</li> <li>• (3DP) Three-Dimensional Printing</li> <li>• (LENS) Laser Engineered Net Shaping</li> <li>• (MJS) Multiphase Jet Solidification</li> <li>• (EBM) Electron Beam Melting</li> </ul>	08
<b>06</b>	<p><b>Advances in RP Systems and Case Studies</b></p> <ul style="list-style-type: none"> <li>• Advances in RP: Resolution &amp; Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications.</li> <li>• Case Study: Wind-Tunnel Testing with RP Models</li> <li>• Case Study: Investment Casting with RP</li> </ul>	08

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **References:**

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid Prototyping Principles and Applications”, World Publishing Co. Pte. Ltd.
2. James O. Hamblen, and Michael D. Furman, “Rapid Prototyping of Digital Systems”, Kluwer Academic Publishers.
3. Kenneth G. Cooper, “Rapid Prototyping Technology Selection and Application”, 2001, Marcel Dekker Inc, New York.
4. Ali Kamrani, EmadAbouel Nasr, “Rapid Prototyping Theory and Practice”, 2006, Springer Inc.
5. Bopaya Bidanda, Paulo J. Bartolo, “Virtual Prototyping and Bio Manufacturing in Medical Applications”, 2008, Springer Inc.
6. I. Gibson, D.W. Rosen, and B. Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, 2010, Springer Inc

Course Code	Course Name	Credits
<b>MDDLO 1013</b>	<b>Fracture Mechanics</b>	<b>04</b>

### Objectives

1. To develop detailed understanding of fracture mechanics, creep, and fatigue.
2. To study environmentally-assisted cracking.
3. To study numerical and experimental methods involved in fracture mechanics.

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

1. Analyse elastic and elastic-plastic stress fields at the crack-tip in a solid material.
2. Estimate crack growth based on energy balance
3. Demonstrate standard fracture mechanics tests for finding J-Integral and Crack Opening Displacement.
4. Inspect a solid material for the presence of crack.

Module	Detailed Contents	Hrs.
01	<b>Introduction</b> <ul style="list-style-type: none"> <li>• A Crack in a Structure</li> <li>• Fracture Toughness</li> <li>• Micro and Macro Phenomena of Fracture <ul style="list-style-type: none"> <li>- Microscopic Aspects: Surface Energy, Theoretical Strength, Microstructure and Defects, Crack Formation</li> <li>- Macroscopic Aspects: Crack Growth, Types of Fracture</li> </ul> </li> <li>• Mechanisms of Fracture and Crack Growth <ul style="list-style-type: none"> <li>- Cleavage Fracture, Ductile Fracture, Fatigue Cracking, Environment Assisted Cracking, Creep Fracture, Service Failure Analysis</li> </ul> </li> </ul>	08
02	<b>Linear Elastic Stress Fields in Cracked Bodies</b> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Crack Deformation Modes and Basic Concepts</li> <li>• Westergaard Method</li> <li>• Singular Stress and Displacement Fields</li> <li>• Stress Intensity Factor Solutions</li> <li>• Three-Dimensional Cracks</li> </ul> <b>Linear Elastic-Plastic Stress Fields in Cracked Bodies</b> <ul style="list-style-type: none"> <li>• Approximate Determination of the Crack-Tip Plastic Zone</li> <li>• Irwin's Model, Dugdale's Model</li> </ul>	10
03	<b>Crack Growth Based on Energy Balance</b> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Energy Balance During Crack Growth</li> <li>• Griffith Theory</li> <li>• Graphical Representation of the Energy Balance Equation</li> <li>• Equivalence between Strain Energy Release Rate and Stress Intensity Factor</li> <li>• Compliance</li> <li>• Crack Stability</li> </ul>	10
04	<b>Fracture Criteria</b> <ul style="list-style-type: none"> <li>• Critical Stress Intensity Factor Fracture Criterion</li> <li>• J-Integral and Crack Opening Displacement Fracture Criteria</li> <li>• Strain Energy Density Failure Criterion: Mixed-Mode Crack Growth</li> </ul>	08

<b>05</b>	<b>Dynamic Fracture</b> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Mott's Model</li> <li>• Stress Field around a Rapidly Propagating Crack</li> <li>• Strain Energy Release Rate</li> <li>• Crack Branching, Crack Arrest</li> <li>• Experimental Determination of Crack Velocity and Dynamic Stress Intensity</li> </ul>	08
<b>06</b>	Introduction to Fatigue Fracture, Environment-Assisted Fracture, Creep Fracture and Crack Detection Methods such as Dye Penetration, Magnetic Particles, Eddy Current, Radiography, Ultrasonics, and Acoustic Emission	08

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **References:**

1. E.E. Gdoutos, "Fracture Mechanics - An Introduction", Springer
2. D. Broek, "Elementary Engineering Fracture Mechanics", Kluwer Academic Publishers
3. R.W. Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials", Wiley India Pvt. Ltd.
4. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications ", CRC - Taylor and Francis
5. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill Education Pvt. Ltd.

Course Code	Course Name	Credits
<b>MDDL01014</b>	<b>Composite Materials</b>	<b>04</b>

### Objectives

1. To study the behaviour of composite materials, both at micro and macro levels.
2. To study the procedure of designing a composite laminate and structure as a whole for the given application.
3. To study the applicability of composite materials for various industrial applications
4. To study the design procedure, damage detection, and damage repair methods for composite materials

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

1. Select the type of material for the fibres and matrix in a composite material for the given application.
2. Select the number of laminae and their stacking sequence in a composite material for the given loading condition.
3. Identify the type of damage occurred in a composite structure and select an appropriate method to possibly repair it.

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Introduction</b> Classifications, Advantages, Applications, Terminology, Manufacturing Methods	08
<b>02</b>	<b>Macro-mechanical analysis of a lamina</b> Hooke's law for different types of materials, Plane stress assumption, Hooke's law for a two-dimensional unidirectional lamina, Relationship of compliance and stiffness matrix to engineering elastic constants of a lamina	10
<b>03</b>	<b>Micro-mechanical analysis of a lamina</b> Assumptions, Volume fraction, Mass fraction, Density, Void content, Prediction of mechanical properties of composites based on properties of their constituents (fiber and matrix) including strength and coefficients of thermal and moisture expansion	08
<b>04</b>	<b>Lamina strength analysis</b> Introduction, Maximum stress failure theory, Maximum strain failure theory, Tsai-Hill failure theory, Tsai-Wu failure theory, Strength ratio, Failure envelopes, Progressive failure analysis for a laminate	08
<b>05</b>	<b>Analysis of laminates</b> Classical laminated plate theory, Global stress-strain relation for laminates based on the individual properties of their laminae and their lay-up, Stresses and strains in individual laminae, Thermal and moisture effects in laminates	10
<b>06</b>	<b>Design, inspection, and repair</b> Advantages and disadvantages of composites with respect to product lifecycle management, General considerations and process involved in composite structural design, Different types of damages in composites, Non-destructive testing of composites, Types of composite repair and their benefits	08

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. R.M. Jones, "Mechanics of Composite Materials", Taylor and Francis, Inc.
2. J.N. Reddy, "Mechanics of Laminated Composite Plates and Shells – Theory and Analysis", CRC Press
3. A.K. Kaw, "Mechanics of Composite Materials", Taylor and Francis Group, LLC
4. D. Hull and T.W. Clyne, "An Introduction to Composite Materials", Cambridge University Press
5. L.P. Kollar, G.S. Springer, "Mechanics of Composite Structures", Cambridge University Press

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

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<b>Introduction to Product Lifecycle Management (PLM):</b> Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications <b>PLM Strategies:</b> Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	<b>Product Design:</b> Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	<b>Product Data Management (PDM):</b> Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	<b>Virtual Product Development Tools:</b> For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	<b>Integration of Environmental Aspects in Product Design:</b> Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	<b>Life Cycle Assessment and Life Cycle Cost Analysis:</b> Properties, and Framework of LCA, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **REFERENCES:**

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265



Course Code	Course Name	Credits
ILO 1012	Reliability Engineering	03

**Objectives:**

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

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

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

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

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **REFERENCES:**

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conon, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

<b>Course Code</b>	<b>Course Name</b>	<b>Credits</b>
<b>ILO 1013</b>	<b>Management Information System</b>	<b>03</b>

**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

<b>Module</b>	<b>Detailed Contents</b>	<b>Hrs</b>
<b>01</b>	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.	4
<b>02</b>	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	7
<b>03</b>	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
<b>04</b>	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
<b>05</b>	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
<b>06</b>	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

**Assessment:**

**Internal:**

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

**End Semester Theory Examination:**

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

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

**REFERENCES:**

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 1014	Design of Experiments	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction</b></p> <p>1.1 Strategy of Experimentation</p> <p>1.2 Typical Applications of Experimental Design</p> <p>1.3 Guidelines for Designing Experiments</p> <p>1.4 Response Surface Methodology</p>	06
02	<p><b>Fitting Regression Models</b></p> <p>2.1 Linear Regression Models</p> <p>2.2 Estimation of the Parameters in Linear Regression Models</p> <p>2.3 Hypothesis Testing in Multiple Regression</p> <p>2.4 Confidence Intervals in Multiple Regression</p> <p>2.5 Prediction of new response observation</p> <p>2.6 Regression model diagnostics</p> <p>2.7 Testing for lack of fit</p>	08
03	<p><b>Two-Level Factorial Designs and Analysis</b></p> <p>3.1 The <math>2^2</math> Design</p> <p>3.2 The <math>2^3</math> Design</p> <p>3.3 The General <math>2^k</math> Design</p> <p>3.4 A Single Replicate of the <math>2^k</math> Design</p> <p>3.5 The Addition of Center Points to the <math>2^k</math> Design,</p> <p>3.6 Blocking in the <math>2^k</math> Factorial Design</p> <p>3.7 Split-Plot Designs</p>	07
04	<p><b>Two-Level Fractional Factorial Designs and Analysis</b></p> <p>4.1 The One-Half Fraction of the <math>2^k</math> Design</p> <p>4.2 The One-Quarter Fraction of the <math>2^k</math> Design</p> <p>4.3 The General <math>2^{k-p}</math> Fractional Factorial Design</p> <p>4.4 Resolution III Designs</p> <p>4.5 Resolution IV and V Designs</p> <p>4.6 Fractional Factorial Split-Plot Designs</p>	07

<b>05</b>	<b>Conducting Tests</b> 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	07
<b>06</b>	<b>Taguchi Approach</b> 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **REFERENCES:**

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup> edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2<sup>nd</sup> Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 1015	Operations Research	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction to Operations Research:</b> Introduction, , Structure of the Mathematical Model, Limitations of Operations Research</p> <p><b>Linear Programming:</b> 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,</p> <p><b>Duality,</b> Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis</p> <p><b>Transportation Problem:</b> Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.</p> <p><b>Assignment Problem:</b> 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</p> <p><b>Integer Programming Problem:</b> Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	14
02	<p><b>Queuing models:</b> queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
03	<p><b>Simulation:</b> 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</p>	05
04	<p><b>Dynamic programming.</b> Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.</p>	05
05	<p><b>Game Theory.</b> 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.</p>	05

<b>06</b>	<b>Inventory Models:</b> Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05
-----------	---	----

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **REFERENCES:**

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.



Course Code	Course Name	Credits
<b>ILO 1016</b>	<b>Cyber Security and Laws</b>	<b>03</b>

**Objectives:**

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

**Outcomes:** 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

Module	Detailed Contents	Hrs
<b>01</b>	<b>Introduction to Cybercrime:</b> 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.	4
<b>02</b>	<b>Cyber offenses &amp; Cybercrime:</b> How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
<b>03</b>	<b>Tools and Methods Used in Cyberline</b> Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
<b>04</b>	<b>The Concept of Cyberspace</b> E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
<b>05</b>	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
<b>06</b>	<b>Information Security Standard compliances</b> SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

**Assessment:**

**Internal:**

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

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

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

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

**REFERENCES:**

1. Nina Godbole, SunitBelapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kenneth J. Knapp, *Cyber Security & Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
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	Course Name	Credits
ILO 1017	Disaster Management and Mitigation Measures	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.

Module	Detailed Contents	Hrs
01	Introduction <i>1.1</i> 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.	03
02	Natural Disaster and Manmade disasters: <i>2.1</i> 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 <i>2.2</i> 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.	09
03	Disaster Management, Policy and Administration <i>3.1</i> Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. <i>3.2</i> 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.	06
04	Institutional Framework for Disaster Management in India: <i>4.1</i> 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. <i>4.2</i> Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: <i>5.1</i> 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. <i>5.2</i> International relief aid agencies and their role in extreme events.	09

<b>06</b>	<p><b>Preventive and Mitigation Measures:</b></p> <p>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general</p> <p>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication</p> <p>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.</p> <p>6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.</p>	06
-----------	---	----

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **REFERENCES:**

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
  2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
  3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
  4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
  5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
  6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
  7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yongng – Prentice Hall (India) Publications.
- (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 1018	Energy Audit and Management	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<b>Energy Scenario:</b> Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	<b>Energy Audit Principles:</b> 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& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	<b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. <b>Energy efficiency measures in lighting system, Lighting control:</b> 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.	10
04	<b>Energy Management and Energy Conservation in Thermal Systems:</b> 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.	10
05	<b>Energy Performance Assessment:</b> 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.	04
06	<b>Energy conservation in Buildings:</b> Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **REFERENCES:**

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. [www.energymanagertraining.com](http://www.energymanagertraining.com)
9. [www.bee-india.nic.in](http://www.bee-india.nic.in)

Course Code	Course Name	Credits
<b>MDL101</b>	<b>Vibration Measurement and Analysis</b>	<b>01</b>

**Objectives:**

1. To study the mathematical simulation software for analysis of single and multi degree freedom problem.
2. To study the finite element analysis software for different analysis and active control vibration.
3. Perform experimentation and processing the data and demonstration of condition based maintenance tool.

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

1. Apply and analyze different systems using mathematical simulation software.
2. Apply FEA software for different analysis techniques.
3. Demonstrate acquiring and processing of data.

Module	Detailed content	Lab Sessions
<b>1</b>	<b>Simulation study using mathematical simulation software (or any programming language) on</b> a. Single DOF system b. Multi DOF system	03
<b>2</b>	<b>Simulation study using finite element software on</b> a. Modal analysis b. Transient analysis c. Harmonic analysis d. Active vibration control	04
<b>3</b>	<b>Experimentation</b> a. Acquiring time domain vibration data by using sensors (displacement / velocity / acceleration) b. Processing the time domain data acquired in experiment 3 (a) using FFT tool to obtain vibration frequencies c. Performing modal analysis of beam / plate type structures d. Demonstration of condition based maintenance tool using vibration techniques	06

**Assessment:**

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

Course Code	Course Name	Credits
<b>MDL102</b>	<b>Finite Element Analysis</b>	<b>01</b>

**Objectives:**

1. To study the mathematical simulation software.
2. To study the finite element analysis software.
3. To apply Finite Element Analysis for real life mechanical component.

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

1. Apply and analyze different mechanical components using mathematical simulation software.
2. Apply and analyze different mechanical components using FEA software.
3. Analyse complex real life mechanical component.

Module	Detailed content	Hours
<b>1</b>	Finite element analysis (FEA) of minimum 05 mechanical components using mathematical simulation software (or any programming language) which must include structural, thermal and coupled structural-thermal analyses	03
<b>2</b>	Finite element analysis of minimum 05 mechanical components using available FEA software which must include structural, thermal and coupled structural-thermal analyses	06
<b>3</b>	<b>Laboratory Project:</b> Finite Element Analysis of a real life mechanical component subjected to both structural and thermal loading, using Mathematical Simulation Software (or any programming language) and Finite Element Analysis Software	04

**Assessment:**

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

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



Course Code	Course Name	Credits
<b>MDC201</b>	<b>System Modeling and Analysis</b>	<b>04</b>

### Objectives

1. To study the fundamental concepts of Control systems and mathematical modeling of the system.
2. To study the concept of time response and frequency response of the system.
3. To study stability analysis in time and frequency domains.  
To study the advanced modeling and simulation techniques.

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

1. Mathematically model a given system and determine its response for various inputs.
2. Analyze the stability of the system
3. Apply the concepts of advanced modeling and simulation techniques

Module	Detailed Contents	Hrs.
01	<b>Introduction to System and Mathematical Modeling</b> System, environment and variables, the state of a system, Physical Laws for Modeling of System, Representation of System in terms of Block Diagram, Reduction of Multiple Subsystems, Signal Flow Graph, Mason's Gain Formula.	08
02	<b>Modeling in the frequency domain</b> Laplace Transform Review, The Transfer Function, Electrical Network Transfer Functions, Translational Mechanical System, Rotational Mechanical System, Transfer Functions for Systems with Gears, Electromechanical System, Fluid Systems, Thermal Systems, Electric Circuit Analogs, Nonlinearities, Linearization.	10
03	<b>Modeling in the time domain</b> The General State-Space Representation, Applying the State-Space Representation, Converting a Transfer Function to State Space, Converting from State Space to a Transfer Function, Linearization.	06
04	<b>Time response</b> Poles, Zeros, and System Response, First-Order Systems, The General Second-Order System, Underdamped Second-Order Systems, System Response with Additional Poles, System Response With Zeros, Effects of Nonlinearities Upon, Time Response, Laplace Transform Solution of State Equations, Time Domain Solution of State Equations.	08
05	<b>Stability of System</b> Linear & Nonlinear System, Stability in Linear and Nonlinear System, Routh-Hurwitz Criterion, Routh-Hurwitz Criterion, Stability in State Space, Phase Plane Method for Nonlinear System. <b>Root locus techniques</b> Introduction, Defining the Root Locus, Properties of the Root Locus, Sketching the Root Locus. <b>Frequency response techniques</b> Introduction, Asymptotic Approximations: Bode Plots, Introduction to the Nyquist Criterion, Sketching the Nyquist Diagram, Stability via the Nyquist Diagram, Gain Margin and Phase Margin via the Nyquist Diagram, Stability, Gain Margin, and Phase Margin via Bode Plots	12
06	<b>Advanced Modeling and Simulation Techniques</b> Introduction to Lyapunov Stability and Modeling via Lyapunov, Nonlinear Modeling Techniques such as consideration of Structural Nonlinearity and Material Nonlinearity	08

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. Nicola Bellomo and Luigi Preziosi, "Modeling Mathematical Methods & Scientific Computations", 1995, CRC Press.
2. I.J. Nagarath and M. Gopal, "Systems Modeling & Analysis", Tata McGraw Hill, New Delhi.
3. Jan Willen Polderman and Jan C. Willems, "Introduction to Mathematical Systems Theory- A behavioral Approach", 1998, Springer.
4. J.L. Shearer, A.T. Murphy and H.H. Richardson, "Introduction to System Dynamics", 1971, Addison & Wesley.
5. Norman S. Nise, "Control Systems Engineering", Sixth Edition, 2011, John Wiley & Sons, Inc.
6. Ogata, "Modern Control Engineering", Prentice Hall.
7. Ogata, "System Dynamics", Pearson Education.
8. Hung V Vu & R.S. Esfandi, "Dynamics Systems - Modeling and Analysis", The McGraw-Hill Companies Inc

Course Code	Course Name	Credits
<b>TEC202</b>	<b>Optimization</b>	<b>04</b>

### Objectives

1. To study the concept of integration of various parameters and the significance of optimizing them in allied Industries.
2. To study the use of practice oriented mathematical applications for optimization functions in an organization.
3. To study the various tools of optimization 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. Apply and analyze mathematical optimization functions to various applications.
3. Demonstrate cost effective strategies in various applications in industry.

Module	Detailed Contents	Hrs.
01	<p><b>Basic Concepts:</b> Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Overview of optimization technique, Interdisciplinary nature, Introduction to related software.</p> <p><b>Linear Programming Problem:</b> Formulation, Simplex method, Primal to Dual, Dual Simplex method, Sensitivity Analysis</p>	12
02	<p><b>Integer L.P. Model:</b> Graphical Representation, Concept of Cutting Plane, Gomory's cutting plane method, Gomory's Method for All Integer programming and Mixed Integer Programming and Branch and Bound Technique.</p>	08
03	<p><b>Classical Optimization Technique:</b> Necessary and sufficient condition for Single and Multivariable optimization problem. Multivariable Optimization with Equality Constraints by Lagrangian method. Multivariable Optimization with Inequality Constraints by Kuhn tucker method.</p>	08
04	<p><b>Unconstrained Optimization Technique:</b> Search method: Unrestricted Search with fixed and accelerated step size, Fibonacci Method and Golden Section Method. <b>Interpolation method:</b> Quadratic and Cubic Interpolation. <b>Direct search method:</b> Random search, Pattern search and Rosen Brock's hill climbing method.</p>	08
05	<p><b>Newtonian Method:</b> Newton's method, Marquardt's method, Quasi Newton method. Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique</p>	08
06	<p><b>Response Surface Method:</b> Response Surface, The Least-Squares Methods, Two-Level Factorial Design, Addition of Center Points, Central Composite Design(CCD), Sequential Nature of RSM, Other Experimental Design.</p>	08

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. RanjanGanguli, "Engineering Optimization - A Modern Approach" Universities Press.
2. Pablo Pedregal, "Introduction to Optimization", Springer
3. S.S. Rao, "Engineering Optimization - Theory and Practice", New Age International Publisher.
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.
6. Mohan Joshi and Kannan Moudgalya, "Optimization - Theory and Practice", Narosa Publishing House.
7. Kalyanmoy Deb, "Optimization for Engineering Design- Algorithms and Example", PHI Learning Private Limited.

Course Code	Course Name	Credits
<b>MDC203</b>	<b>Machine Tool Design</b>	<b>04</b>

### Objectives

1. To study general principles of machine tool design.
2. To study the procedure of designing machine tool drives.
3. To study the acceptance test for various machine tools.

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

1. Understand the functioning of various machine tools.
2. Design a machine tool component for the given loading conditions.
3. Apply the acceptance tests on various machine tools.

Module	Detailed Contents	Hrs.
01	<b>Introduction to Machine Tools, General Principles of Machine Tool Design:</b> Types and capabilities of machine tools, Constructional and operational features, Techno-Economical Prerequisites for undertaking the Design of New Machine Tool, General Requirements of Machine Tool Design, Engineering Design Process Applied to Machine Tools	08
02	<b>Machine Tool Drives</b> Working and auxiliary motions in machine tools, Mechanical transmission and its elements, Aim of Speed and Feed Rate Regulation, Stepped regulation of speed: Design of speed box, Design of Feed Box, Construction of speed charts, Development of gearing diagram, Determination of gear teeth ,module, shaft sizes, centre distances, Other types of speed and feed drives viz Quadrant change gear, Gear cone with sliding key, Norton Gear Box, Meander Drive, Gear boxes with clutched drive like the Ruppert Drive and Schopke drive, Stepless Drives-Mechanical, Hydraulic, Electrical	10
03	<b>Design of Machine Tool Structures and guide ways</b> Functions of Machine Tool Structures and Their Requirements, Design criteria for Machine Tool Structures, Materials of Machine Tool Structures Static and Dynamic Stiffness, Profiles of Machine Tool Structures, Basic Design Procedure of Machine Tool Structures, Design of Beds, Columns, Bases and Tables, Functions and types of guide ways, Design of slide ways, Design calculations for slide ways, Guide ways operating under liquid friction conditions	10
04	<b>Design of Power Screws:</b> Design of Power Screws based on strength, stiffness and buckling, Power requirements	08
05	<b>Design of Spindles and Spindle Supports:</b> Functions of Spindle Unit and Requirements, Materials of Spindles, Effect of Machine Tool Compliance on Machining Accuracy, Design Calculations of Spindle	10
06	<b>Acceptance Tests for Machine Tools:</b> Significance, Performance and geometrical tests for lathe, milling, drilling and shaping machines	06

## **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. N.K. Mehta, "Machine Tool Design and Numerical Control" Second Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1984.
2. S.K. Basu and D.K. Pal, "Design of Machine Tools", Fourth Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1990.
3. G.C. Sen and A. Bhattacharya, "Principles of Machine Tools", Second Edition, New Central Book Agency (P) Ltd., Kolkata, 1988.
4. F. Koenigsberger, "Design Principles of Metal Cutting and Machine Tools", Edition 1964, Pergamon Press Ltd., London.
5. H.C. Town, "The Design and Construction of Machine Tools", Central Machine Tool Research Institute, Bangalore, Machine Tool Design Handbook.
6. PSG College of Engg. & Technology, PSG Design Data Book.
7. N.K. Acherkan, "Machine Tool Design (Vol.I to Vol.IV)", Mir Publishers.

Course Code	Course Name	Credits
<b>MDDL0 2021</b>	<b>Theory of Plates</b>	<b>04</b>

### Objectives

1. To study the classical plate theory
2. To study the analyses of rectangular and circular plates
3. To study approximate methods to solve problems related to the plates
4. To study advances in theory of plates

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

1. Understand classical plate theory and apply to standard plate problems
2. Understand the behaviour of rectangular and circular plates under the given loading conditions
3. Make use of approximate methods to solve plate problems
4. Analyse complex problems related to orthotropic / layered plates

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Classical Plate Theory (CPT)</b> <ul style="list-style-type: none"> <li>• The Elasticity Approach</li> <li>• Assumptions of Classical Plate theory</li> <li>• Moment Curvature Relations</li> <li>• Equilibrium Equations</li> <li>• Governing Biharmonic Equation</li> <li>• Boundary Conditions</li> <li>• Solution of a Problem</li> <li>• Strain Energy of the Plate</li> </ul>	08
<b>02</b>	<b>Analysis of Rectangular Plates</b> <ul style="list-style-type: none"> <li>• Recapitulation of Fourier Series</li> <li>• Navier's Method</li> <li>• Levy's Method</li> </ul>	10
<b>03</b>	<b>Analysis of Circular Plates</b> <ul style="list-style-type: none"> <li>• Equations of the Theory of Elasticity</li> <li>• Equations of CPT</li> <li>• Solution for Axisymmetric Problems</li> </ul>	08
<b>04</b>	<b>Dynamics and Stability</b> <ul style="list-style-type: none"> <li>• Dynamics of Rectangular Plates</li> <li>• Stability of Rectangular Plates</li> </ul>	08
<b>05</b>	<b>Approximate Solutions</b> <ul style="list-style-type: none"> <li>• Rayleigh-Ritz Method</li> <li>• Static Flexure</li> <li>• Buckling</li> <li>• Free Vibration Analysis</li> <li>• Galerkin's Method</li> </ul>	08
<b>06</b>	<b>Advanced Topics</b> <ul style="list-style-type: none"> <li>• CPT of Orthotropic Plates</li> <li>• CPT of Layered Plates</li> <li>• CPT of Moderately Large Deformations</li> <li>• Mindlin's Plate Theory</li> </ul>	10

## **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. T.K. Varadan and K. Bhaskar, "Analysis of Plates - Theory and Problems", Narosa Publishing House
2. Stephen P. Timoshenko and S. Woinowsky-Krieger, "Theory of Plates and Shells", Tata McGraw Hill
3. C.M. Wang, J.N. Reddy and K.H. Lee, "Shear Deformable Beams and Plates – Relationships with Classical Solutions", Elsevier
4. N.G.R. Iyengar, "Structural Stability of Columns and Plates", Ellis Horwood Limited.



Course Code	Course Name	Credits
<b>MDDLO 2022</b>	<b>Micro Electro Mechanical Systems</b>	<b>04</b>

### Objectives

1. To introduce basic concepts of MEMS and its applications.
2. To introduce sensors and actuators in Micro-domain.
3. To study modelling and simulation techniques for various applications.
4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system

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

1. Select appropriate sensors and actuators for a given MEMS application.
2. Select a micro-fabrication technique for a specific MEMS fabrication process.
3. Model and simulate a given MEMS system

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Introduction to MEMS &amp; Applications</b> <ul style="list-style-type: none"> <li>• Introduction to Micro-Electro-Mechanical Systems,</li> <li>• Applications and Materials,</li> <li>• Advantages &amp; Disadvantages of Micro-sensors, and micro-actuators.</li> </ul>	04
<b>02</b>	<b>Sensors and Actuators in Micro-domain</b> <ul style="list-style-type: none"> <li>• Concept of Sensors &amp; Actuators,</li> <li>• Sensing &amp; Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys</li> <li>• Comb Drive Actuation &amp; Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors</li> <li>• Sensors &amp; Actuators for Automotive, Biomedical, Industrial applications</li> <li>• Design of sensor and actuator for few applications such as automobile accelerometer, bimetallic temperature sensor, etc.</li> </ul>	08
<b>03</b>	<b>Fabrication Methods</b> Microfabrication Methods (VLSI Techniques) <ul style="list-style-type: none"> <li>• Positive and Negative Photoresists,</li> <li>• Bulk Micromachining,</li> <li>• Surface Micromachining,</li> <li>• Etching (Isotropic and Anisotropic),</li> <li>• Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques.</li> </ul> 3D High Aspect Ratio Techniques <ul style="list-style-type: none"> <li>• LIGA,</li> <li>• AMANDA,</li> <li>• Microstereolithography,</li> <li>• IH-Process,</li> <li>• X-Ray Techniques,</li> <li>• Ion-beam Lithography etc.</li> </ul>	08

04	<p><b>Modelling and Simulation Techniques</b></p> <ul style="list-style-type: none"> <li>• Scaling Laws, Governing Equations</li> <li>• Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis</li> <li>• Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling</li> <li>• Modelling of Micro-channel as heat exchanger, accelerometers, micro-hinges, compound microstructures.</li> <li>• Linear &amp; Nonlinear Model.</li> <li>• Numerical Methods used for MEMS analysis.</li> </ul>	10
05	<p><b>Characterization Techniques</b></p> <p>Topography Methods (Optical, Electrical and Mechanical Methods)</p> <ul style="list-style-type: none"> <li>• Microscopy, STM (Scanning Tunneling Microscopes),</li> <li>• SEM (Scanning Electron Microscopes),SPM (Scanning ProbeMicroscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis</li> <li>• Deformation &amp; Vibration Measurement Techniques (Piezo resistive and piezo electric)</li> <li>• Interferometry Techniques,</li> <li>• SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle PatternInterferometry),</li> <li>• Laser Techniques, Laser Doppler Vibro-metersFluid, Thermal and Chemical Analysis</li> <li>• Thermal Analysis Techniques (Theoretical and Experimental),</li> <li>• Fluid Flow Pattern Analysis,</li> <li>• Electro-chemical Analysis, PIV Techniques -spectroscopy</li> </ul>	12
06	<p><b>Introduction to Advances of MEMS and Nanotechnology</b></p> <ul style="list-style-type: none"> <li>• CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method,</li> <li>• Nano-mechanical Systems (NEMS),</li> <li>• Nano-tribology, &amp;nano-indentation techniques,</li> <li>• Domestic and Industrial Applications of nanotechnology</li> <li>• Molecular Modelling Techniques.</li> <li>• Social and Ethical Implications of nanotechnology in Society</li> </ul>	10

### **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. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim “Microsensors MEMS and Smart devices”, John Wiley and sons, Ltd.
2. Nadim Mulaf and Kirt Williams, “An Introduction to Microelectromechanical systems Engineering”, Artech House.
3. Nicolae Lobontiu and Ephraim Garcia, “Mechanics of Microelectromechanical systems”, Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, “Silicon Processing for the VLSI era Volume -1 Technology”, Lattice press.
5. Vijay K. Varadan, K.J. Vinoy and S. Gopalkrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, John Wiley and sons Ltd.
6. Bhushan, “Springer Handbook of Nanotechnology”, Springer Inc.

Course Code	Course Name	Credits
<b>MDDL0 2023</b>	<b>Smart Materials</b>	<b>04</b>

### Objectives

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

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

1. Understand working of smart materials and their application as actuator and sensor.
2. Select an appropriate smart material for a given application.
3. Identify applicability of smart materials for new prospective smart structures

Module	Detailed Contents	Hrs.
01	<p><b>Introduction to Smart / Intelligent Materials:</b></p> <ul style="list-style-type: none"> <li>• Overview of Smart / Intelligent Materials, Primitive Functions of Intelligent Materials, Intelligence Inherent in Materials, Actuator Materials, Sensing Technologies, Microsensors, Intelligent Systems</li> <li>• Hybrid Smart Materials, Passive Sensory Smart Structures, Reactive Actuator based Smart Structures, Active Sensing and Reactive Smart Structures, Smart Skins.</li> </ul>	08
02	<p><b>Introduction to High bandwidth - Low strain generating (HBL) Smart Materials</b></p> <ul style="list-style-type: none"> <li>• Piezoelectric Materials <ul style="list-style-type: none"> <li>- Constitutive relationship, electromechanical coupling coefficients, piezoelectric constants, piezoceramic materials, variation of coupling coefficients in hard and soft piezoceramics, polycrystalline vs single crystal piezoelectric materials, polyvinylidene fluoride, piezoelectric composites</li> </ul> </li> <li>• Magnetostrictive Materials <ul style="list-style-type: none"> <li>- Constitutive relationship, magnetomechanical coupling coefficients, Joule Effect, Villari Effect, Matteucci Effect, Wiedemann effect, Giant magnetostriction in Terfenol-D, Terfenol-D particulate composites, Galfenol and Metglas materials</li> </ul> </li> </ul>	10
03	<p><b>Actuators based on HBL Smart Materials</b></p> <ul style="list-style-type: none"> <li>• Piezoelectric Actuators <ul style="list-style-type: none"> <li>- Induced Strain actuation model, Unimorph and Bimorph Actuators, Actuators embedded in composite laminate, Impedance matching in Actuator design, Feedback Control, Pulse Drive, Resonance Drive.</li> </ul> </li> <li>• Magnetostrictive Actuators <ul style="list-style-type: none"> <li>- Magnetostrictive Mini Actuators, Thermal instabilities, Discretely distributed actuation, Magnetostrictive Composites.</li> </ul> </li> <li>• MEMS based Actuators <ul style="list-style-type: none"> <li>- Piezoelectric Micropumps, Magnetostrictive micromechanisms, Imaging System Applications, Inchworm Devices, Inkjet Printers, Piezoelectric Relays, Ultrasonic Motors, and Microscale Walking Machines.</li> </ul> </li> </ul> <p><b>Sensors based on HBL Smart Materials</b></p> <ul style="list-style-type: none"> <li>• Piezoelectric Sensors, Magnetostrictive Sensors, Techniques of Self-Sensing, MEMS Sensors</li> </ul>	10
04	<p><b>Introduction to Low bandwidth - High strain generating (LBHS) materials</b></p> <ul style="list-style-type: none"> <li>• Shape Memory Alloys (SMA)</li> <li>• Electro-active Polymers (EAP)</li> </ul>	08

<b>05</b>	<p><b>Actuators based on LBHS Smart Materials</b></p> <ul style="list-style-type: none"> <li>• Shape Memory Alloy based actuators for Shape Control</li> <li>• Electro-active Polymers for Work-Volume Generation</li> </ul> <p><b>Sensors based on LBHS Smart Materials</b></p> <ul style="list-style-type: none"> <li>• EAP based sensors</li> <li>• SMA based encoders</li> <li>• Optical Fibre based Sensing</li> </ul>	08
<b>06</b>	<p><b>Advances in Smart Materials</b></p> <ul style="list-style-type: none"> <li>• Active Fibre Composites (AFC)</li> <li>• Energy Harvesting Actuators and Energy Scavenging Sensors</li> <li>• Self-healing and Autophagous Smart Materials</li> </ul>	08

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **References:**

1. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman & Hall, London; New York, 1992 (ISBN: 0412370107)
2. Mel Schwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
3. H. Janocha, "Actuators - Basics and Applications", Springer
4. B. Culshaw, "Smart Structures and Materials", Artech House, Boston, 1996 (ISBN:0890066817)
5. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267)
6. A.J. Moulson and J.M. Herbert, "Electroceramics: Materials, Properties, Applications", 2nd Edition, John Wiley & Sons, Chichester, West Sussex; New York, 2003 (ISBN:0471497479)
7. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
8. G. Engdahl, "Handbook of Giant Magnetostrictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
9. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
10. Eric Udd, "Fiber Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
11. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
12. T.T. Soong, "Passive Energy Dissipation Systems in Structural Engineering", Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

Course Code	Course Name	Credits
<b>MDDL0 2024</b>	<b>Tribology</b>	<b>04</b>

### Objectives

1. To study the fundamental properties of lubricants and their applications.
2. To study various mechanisms of friction and wear in a material.
3. To study different types of bearings and their selection procedure.

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

1. Select an appropriate lubricant for a given application.
2. Understand various friction and wear mechanisms so that he can think of remedial measures.
3. Select an appropriate type of bearing for a given application.

Module	Detailed Contents	Hrs.
<b>01</b>	<b>Introduction</b> Tribology, Industrial Importance, Friction and Wear, Lubricants, Types and Properties of Lubricants, Viscosity and Viscometry, Bearings	08
<b>02</b>	<b>Friction</b> Introduction, Laws of Friction, Friction Theories, Other Mechanisms: - Hysteresis - Ratchet Mechanism - Stick-Slip - Rolling Friction Friction on Metals, Friction on Non-Metallic Materials <b>Wear</b> Mechanisms of Wear: - Abrasive - Adhesive - Surface Fatigue - Tribo-chemical Quantitative Laws of Wear, Wear Resistance of Materials	08
<b>03</b>	<b>Rolling Element Bearings</b> Introduction, Selection of Bearings, Stribeck's Equation, Static and Dynamic Load Carrying Capacity, Rated Life, Equivalent Bearing Load, Probability of Survival, Selection of Bearing from Design Data Book	08
<b>04</b>	<b>Hydrodynamic Bearings</b> Introduction, Governing Equations, Hydrodynamic Journal Bearings, Hydrodynamic Thrust Bearings <b>Hydrostatic Bearings</b> Introduction, Circular Step Thrust Bearing, Annular Thrust Pad Bearings, Rectangular Thrust Bearings, Hydrostatic Journal Bearings	12
<b>05</b>	<b>Gas Lubricated Bearings</b> Introduction, Governing Equations, Infinitely Long - Plane Slider Bearings, Infinitely Long - Journal Bearings, Finite Journal Bearings, Other Gas Bearing Types: - Tilted-Pad Journal Bearings - Spiral Groove Thrust and Journal Bearings - Foil Bearings - Externally Pressurized Bearings Squeeze Film Lubrication, Instabilities in Gas-Lubricated Bearings	08

<b>06</b>	<b>Elastohydrodynamic Lubrication (EHL)</b> Introduction, Line Contact: Rigid Cylinder, Line Contact: Elastic Cylinder, Point Contacts, Thermal Correction Factor, Surface Roughness Correction Factor, Lubricant Rheology, Different Regimes in EHL Contacts Introduction to Nanotribology and Biotribology	08
-----------	--	----

### **Assessment:**

#### **Internal:**

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

#### **End Semester Theory Examination:**

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

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

#### **References:**

1. Gwidon W. Stachowiak and Andrew W. Batchelor, "Engineering Tribology", Elsevier Butterworth Heinemann
2. PrasantaSahoo, "Engineering Tribology", PHI Learning Pvt. Ltd.
3. B.C. Majumdar, "Introduction to Tribology of Bearings", Wheeler Publishing
4. John Williams, "Engineering Tribology", Cambridge University Press
5. S.K. Basu, S.N. Sengupta and B.B. Ahuja, "Fundamentals of Tribology", PHI Learning Pvt. Ltd.

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

Module	Detailed Contents	Hrs
01	<b>Project Management Foundation:</b> 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	<b>Initiating Projects:</b> 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	<b>Project Planning and Scheduling:</b> 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	<b>Planning Projects:</b> Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	<b>5.1 Executing Projects:</b> Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. <b>5.2 Monitoring and Controlling Projects:</b> Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. <b>5.3 Project Contracting</b> Project procurement management, contracting and outsourcing,	8
06	<b>6.1 Project Leadership and Ethics:</b> Introduction to project leadership, ethics in projects. Multicultural and virtual projects. <b>6.2 Closing the Project:</b> 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:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup>Ed.
2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

<b>Course Code</b>	<b>Course Name</b>	<b>Credits</b>
<b>ILO 2022</b>	<b>Finance Management</b>	<b>03</b>

**Objectives:**

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

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

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

<b>Module</b>	<b>Detailed Contents</b>	<b>Hrs</b>
<b>01</b>	<p><b>Overview of Indian Financial System:</b> Characteristics, Components and Functions of Financial System.</p> <p><b>Financial Instruments:</b> Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p><b>Financial Markets:</b> Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p><b>Financial Institutions:</b> Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
<b>02</b>	<p><b>Concepts of Returns and Risks:</b> 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.</p> <p><b>Time Value of Money:</b> 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.</p>	06
<b>03</b>	<p><b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p><b>Financial Ratio Analysis:</b> 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.</p>	09
<b>04</b>	<p><b>Capital Budgeting:</b> 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)</p> <p><b>Working Capital Management:</b> 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.</p>	10
<b>05</b>	<p><b>Sources of Finance:</b> Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.</p> <p><b>Capital Structure:</b> 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</p>	05
<b>06</b>	<p><b>Dividend Policy:</b> 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</p>	03

## **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. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11<sup>th</sup> Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO2023	Entrepreneurship Development and Management	03

**Objectives:**

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

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

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	<b>Overview Of Entrepreneurship:</b> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	<b>Business Plans And Importance Of Capital To Entrepreneurship:</b> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur <b>Entrepreneurship And Business Development:</b> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	<b>Indian Environment for Entrepreneurship:</b> key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	<b>Effective Management of Business:</b> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	<b>Achieving Success In The Small Business:</b> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. PoornimaCharantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. LaghuUdyogSamachar
11. [www.msme.gov.in](http://www.msme.gov.in)
12. [www.dcmesme.gov.in](http://www.dcmesme.gov.in)
13. [www.msmetraining.gov.in](http://www.msmetraining.gov.in)

Course Code	Course Name	Credits
ILO2024	Human Resource Management	03

**Objectives:**

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

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

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

Module	Detailed Contents	Hrs
01	<p><b>Introduction to HR</b></p> <ul style="list-style-type: none"> <li>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.</li> <li>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.</li> </ul>	5
02	<p><b>Organizational Behavior (OB)</b></p> <ul style="list-style-type: none"> <li>• Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues</li> <li>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness</li> <li>• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.</li> <li>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);</li> <li>• 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.</li> <li>• Case study</li> </ul>	7
03	<p><b>Organizational Structure &amp; Design</b></p> <ul style="list-style-type: none"> <li>• Structure, size, technology, Environment of organization; Organizational Roles &amp; conflicts: Concept of roles; role dynamics; role conflicts and stress.</li> <li>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.</li> <li>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.</li> </ul>	6
04	<p><b>Human resource Planning</b></p> <ul style="list-style-type: none"> <li>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</li> <li>• Performance Appraisal Systems: Traditional &amp; modern methods, Performance Counseling, Career Planning.</li> <li>• Training &amp; Development: Identification of Training Needs, Training Methods</li> </ul>	5

05	<p><b>Emerging Trends in HR</b></p> <ul style="list-style-type: none"> <li>Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</li> <li>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.</li> </ul>	6
06	<p><b>HR &amp; MIS</b> Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries)</p> <p><b>Strategic HRM</b> 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</p> <p><b>Labor Laws &amp; Industrial Relations</b> Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	10

### **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. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

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

**Objectives:**

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

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

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

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

**Assessment:**

**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.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO2026	Research Methodology	03

**Objectives:**

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

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

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

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

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO2027	IPR and Patenting	03

**Objectives:**

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

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

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	<b>Introduction to Intellectual Property Rights (IPR):</b> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. <b>Importance of IPR in Modern Global Economic Environment:</b> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	<b>Enforcement of Intellectual Property Rights:</b> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement <b>Indian Scenario of IPR:</b> 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.	07
03	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	<b>Basics of Patents:</b> 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	07
05	<b>Patent Rules:</b> 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.)	08
06	<b>Procedure for Filing a Patent (National and International):</b> Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement <b>Patent databases:</b> Important websites, Searching international databases	07

## **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. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
6. LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO
7. PrabhuddhaGanguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, PritiMathur, AnshulRathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
<b>ILO 2028</b>	<b>Digital Business Management</b>	<b>03</b>

**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

Module	Detailed content	Hours
1	<p><b>Introduction to Digital Business-</b> Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, <b>Drivers of digital business-</b> Big Data &amp; Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,</p>	09
2	<p><b>Overview of E-Commerce</b> <b>E-Commerce-</b> Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC</p>	06
3	<p><b>Digital Business Support services:</b> ERP as e –business backbone, knowledge Tope Apps, Information and referral system <b>Application Development:</b> Building Digital business Applications and Infrastructure</p>	06
4	<p><b>Managing E-Business-</b>Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications</p>	06
5	<p><b>E-Business Strategy-</b>E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)</p>	04
6	<p><b>Materializing e-business: From Idea to Realization-</b>Business plan preparation <b>Case Studies and presentations</b></p>	08

## **Assessment:**

### **Internal:**

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

### **End Semester Theory Examination:**

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

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

### **References:**

1. A textbook on E-commerce, ErArunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
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 2<sup>nd</sup> International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

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

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	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.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

**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. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
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
7. Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing.2015

Course Code	Course Name	Credits
<b>MDL201</b>	<b>CAD/CAM/CIM</b>	<b>01</b>

**Objectives:**

1. To study the basics of CAD.
2. To study the basics of CAD.
3. To study Geometric modeling and assembling of any mechanical system.

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

1. Apply knowledge of CAD for generation of curves.
2. Develop GM code or APT for any machining operations.
3. Demonstrate skill of modeling and assembling of any mechanical system.

Module	Detailed content	Lab Sessions
<b>1</b>	<b>CAD</b> a. Executing basic algorithms for generation of line, circle, ellipse in any programming language b. Executing transformations and projection both in 2D and 3D in any programming language c. Generating curves using any programming language	04
<b>2</b>	<b>CAM</b> Developing GM code or APT part program for machining operations such as facing, turning, threading, tapering, drilling, etc. and executing them on the CNC machine	04
<b>3</b>	<b>Laboratory Project</b> Geometric modeling and assembling of any mechanical system consisting of minimum 5 to 6 components using any CAD software and developing GM code or APT part program for manufacturing all the individual components on CNC machines	05

**Assessment:**

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

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

Course Code	Course Name	Credits
<b>MDL202</b>	<b>Measurement &amp; Virtual Instrumentation</b>	<b>01</b>

**Objectives:**

1. To study the different sensors and their calibration.
2. To study the different data acquisition systems available.
3. To study interfacing tool for different sensors and measurement of different parameters.

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

1. Apply knowledge for selecting the sensors for their application.
2. Develop interface and measurement of any parameter with suitable sensor.
3. Demonstrate the skill of Virtual Instrumentation.

Module	Detailed content	Lab Sessions
<b>1</b>	Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature	03
<b>2</b>	<b>Virtual Instrumentation</b> a. Simulation of any system with Virtual Instrumentation (VI) environment using any suitable software. b. Interfacing of sensors used for measuring above mentioned parameters with VI software and measurement of these parameters on any laboratory model or actual working system	05
<b>3</b>	Demonstration of interfacing of VI software with suitable generic hardware.	05

**Assessment:**

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

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

Course Code	Course Name	Credits
<b>MDS301</b>	<b>Seminar</b>	<b>03</b>

**Guidelines for Seminar**

- Seminar should be based on thrust areas in Mechanical Engineering (Machine Design 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

Course Code	Course Name	Credits
<b>MDD301/ MDD401</b>	<b>Dissertation (I and II)</b>	<b>12 + 15</b>

**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)

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