CIRCULAR:--

A reference is invited to the syllabi relating to the Master of Engineering (Mechanical) Thermal Engineering degree course vide this office Circular No.UG/145 of 2012-13, dated 12th March, 2013 and the Principals of affiliated Colleges in Engineering are hereby informed that the recommendation made by Ad-hoc Board of Studies in Electrical Engineering at its meeting held on 8th July, 2016 has been accepted by the Academic Council at its meeting held on 14th July, 2016 vide item No. 4.33 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for Master of Engineering (Mechanical) Thermal Engineering (Sem. I & II), which is available on the University’s web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

MUMBAI – 400 032
November, 2016

To,
The Principals of affiliated Colleges in Engineering.

A.C/ 4.33/14/07/2016.

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

MUMBAI-400 032
November, 2016

Copy forwarded with compliments for information to:-

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

MUMBAI – 400 032
November, 2016

(Dr.M.A.Khan)
REGISTRAR
Revised Syllabus for the M. E. Program

Program: M. E. (Mechanical)

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

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

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

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

**Dr. S. K. Ukarande**

**Co-ordinator,**

**Faculty of Technology,**

**Member - Academic Council**

**University of Mumbai, Mumbai**
Chairman’s Preamble:

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

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

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

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

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

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

## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme (Contact Hours)</th>
<th>Credits Assigned</th>
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<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract</td>
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<tr>
<td>TEC101</td>
<td>Advanced Heat Transfer#</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>TEC102</td>
<td>Refrigeration and Air conditioning System Design</td>
<td>04</td>
<td>--</td>
</tr>
<tr>
<td>TEC103</td>
<td>Numerical Methods and Computational Techniques</td>
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<tr>
<td>TEDLO101X</td>
<td>Department Level Optional Course I</td>
<td>04</td>
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<tr>
<td>ILO101X</td>
<td>Institute Level Optional Course I</td>
<td>03</td>
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<tr>
<td>TEL101</td>
<td>Laboratory I - Simulation of Thermal Systems#</td>
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<tr>
<td>TEL102</td>
<td>Laboratory II - Renewable Energy Lab</td>
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<td>Alternative Fuels #&amp;</td>
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<td>Steam and Gas Turbines</td>
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# Common with Thermal Engineering and Heat Power Engineering

& Common for Thermal Engineering and Energy Systems and Management
## Semester II

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# Common with Thermal Engineering and Heat Power Engineering

& Common with Thermal Engineering and Energy Systems and Management

University of Mumbai, ME (Mechanical) Thermal Engineering, Rev 2016
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<td>TEDLO2023</td>
<td>Advanced Turbo Machinery&lt;sup&gt;Ⅱ&lt;/sup&gt;</td>
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<td>Entrepreneurship Development and Management</td>
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<td>TEDLO2024</td>
<td>Non-Conventional Power Plants&lt;sup&gt;Ⅱ&lt;/sup&gt;</td>
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### Semester III

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<td><strong>Total</strong></td>
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*Seminar of Semester III and Dissertation II of Semester IV should be assessed jointly by the pair of Internal and External Examiners*

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

---

### Semester IV

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<td>TED401</td>
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<th>Course Name</th>
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<td>TED401</td>
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<td><strong>Total</strong></td>
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</table>
Course Code | Course Name | Credits
---|---|---
TEC 101 | Advanced Heat Transfer | 04

Objectives
1. Impart the advances knowledge of heat transfer.
2. Get analytical solutions for Dimensional steady and transient heat conduction problems.
3. Deep understanding on the governing equations for convection heat transfer and its application.
4. Understand the boiling and condensation mechanism.

Outcomes: Learner will be able to…
1. Understand applications of classical heat transfer to practical problems.
2. Exhibit analytical and model synthesis skills needed to apply the fundamentals to a wide variety of complex engineering problems.
3. Design systems requiring significant consideration of heat transfer.

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Introduction to basic laws and general heat conduction equations, boundary and initial conditions. Multidimensional heat transfer. Concept of variable thermal conductivity in plane wall. Thermal contact resistance. Three dimensional heat conduction. Heat transfer enhancement techniques. Active and passive techniques.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td>Heat transfer in common configurations, concept of conduction shape factor. Conduction in porous media. Transient heat conduction: Lumped system analysis. Introduction to transient heat conduction in large plane wall and cylinders with spatial effects.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Natural Convection heat transfer: Solution of convection equation for flat plate. Grashof number. Natural convection over vertical plate, horizontal plate, vertical and horizontal cylinder, spheres. Natural convection cooling of finned surfaces, vertical PCBs. Natural convection inside vertical and horizontal rectangular enclosures, concentric cylinders.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>Forced Convection: Laminar forced convection in long tube, correlations for laminar forced convection. Correlations for coiled tubes, Empirical correlations for turbulent forced convection for circular ducts and tubes.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Introduction to flow boiling, flow patterns in vertical and horizontal tubes, Correlations, post dry-out heat transfer. Condensation: heat transfer correlation for condensation heat transfer for vertical plate. Film condensation inside horizontal tubes and horizontal tubes. Radiation heat transfer: radiation in gases, mean beam length, radiation network for absorbing and transmitting medium.</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td>Numerical methods in heat conduction: Necessity, Limitations, Finite difference formulation of differential equations, Explicit, Crank Nicolson and Fully implicit schemes of discretisation, finite difference formulation of one dimensional heat conduction in a plane wall using the energy balance approach, Boundary conditions. Solution of problems on large plane walls and triangular fins, Control volume formulation, Steady one dimensional convection problems</td>
<td>08</td>
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</tbody>
</table>
Assessment:

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

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

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

References:

**Objectives**
1. To understand industrial refrigeration and air conditioning systems and their analysis
2. Impart knowledge of psychrometry and its application in air conditioning system design
3. Know how about controls in refrigeration and air conditioning

**Outcomes:** Learner will be able to…
1. Analyse performance of various refrigeration cycles and air conditioning systems
2. Identify suitable refrigeration system and propose design of the same
3. Design conventional or non-conventional air conditioning system for specific application

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>REFRIGERATION CYCLES: Analysis, Multi-pressure Systems, REFRIGERANTS: Classification of Refrigerants, Refrigerant Properties, Oil Compatibility, Blends, System Design Criteria for New Refrigerants, Phase-out Schedule, Natural Refrigerants.</td>
<td>09</td>
</tr>
<tr>
<td>02</td>
<td>SYSTEM COMPONENTS : Refrigeration Compressors, Different Types, Performance, Capacity Control, Evaporators, Evaporator Circuitry, Applications and Different Types, Condensers, Types, Evaporative Condensers, Optimum Cooling Water Rate and Velocity, Cooling Towers, Range and Approach, Refrigerant piping, pressure drops, optimum pipe sizing</td>
<td>10</td>
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<tr>
<td>03</td>
<td>VAPOUR ABSORPTION SYSTEMS: LiBr &amp; Aqua Ammonia Systems. Double Effect Chillers. Solar Energy operated m/c’s INDUSTRIAL REFRIGERATION: Cold Stores, Ammonia Refrigeration Systems, Safety requirement for refrigeration systems. Introduction to Refrigeration systems for various applications such as petrochemical, food, pharmaceutical, etc.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>PSYCHROMETRICS: Introduction, Properties of air and water vapour mixture, Psychrometric chart and its use in air conditioning. ASHRAE Comfort Chart</td>
<td>08</td>
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<tr>
<td>05</td>
<td>DESIGN OF EQUIPMENTS: Analysis of air conditioning load, load calculation, Equipment selection and balancing</td>
<td></td>
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<tr>
<td>06</td>
<td>AIR CONDITIONING SYSTEMS: Window Type, Package Type, Split Type, Central Units – direct and indirect. Construction details. Evaporative cooling system AIR DISTRIBUTION: Air Distribution Devices – Air Circuits – Design of Air Supply System. Noise consideration</td>
<td>07</td>
</tr>
<tr>
<td>06</td>
<td>CONTROLS: Electrical components &amp; controls, starting and running circuits, relay types and controls, Temperature, Pressure, Oil Flow controls, Compressor Motor-Protection Devices, Refrigeration valves NON CONVENTIONAL HVAC SYSTEMS: Multi Stage Evaporative Cooling, Simultaneous Cooling and Heating, Adsorption Chillers, radiant Cooling Systems, Geothermal Systems, Magnetic Refrigeration.</td>
<td>08</td>
</tr>
</tbody>
</table>
Assessment:

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

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

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

References:

6. ASHRAE Handbooks (Fundamentals, Equipments and Systems)
8. Shan K Wang, Handbook of Refrigeration & Air Conditioning
### Course Details

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>TEC103</td>
<td>Numerical Methods and Computational Techniques</td>
<td>04</td>
</tr>
</tbody>
</table>

### Objectives
1. To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in Thermal Engineering.
2. To serve as a precursor for future research

### Outcomes:
Learner will be able to…
1. Able to identify and use suitable numerical method to address live engineering problem

### Module Details

<table>
<thead>
<tr>
<th>Module</th>
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<th>Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Algebraic and transcendental equation: Bisection method, Fixed point, Regula-Falsi method, Muller’s method, Newton-Raphson method, Rate of convergence, Merits and demerits of methods</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td>Simultaneous Linear Equations: Motivation, Gauss elimination, Pivoting, Factoring, Solution accuracy, Iterative methods, Jacobi method, Gauss-Siedel method, Relaxation method.</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Interpolation and Curve Fitting: Motivation, Polynomial forms, Linear interpolation, Lagrangean interpolation, Newton interpolation, Spline interpolation, Chebyshev Interpolation, Regression analysis, Fitting linear equations, Least-square method, Fitting transcendental equations, Polynomial functions, Multiple linear regression.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>Numerical integration and differentiation: Maxima and Minima, Trapezoidal rule, Simpson’s 1/3 and 3/8 rule, Weddle’s rule, Euler-Maclaurin’s formula, Gaussian Quadrature formula</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Numerical solution of ordinary differential equation: Picard’s Method of successive approximation, Euler’s Method, Modified Euler’s Method, Runge-Kutta Methods</td>
<td>08</td>
</tr>
</tbody>
</table>

Students have to develop a programme to cater to a real life thermal engineering problem based on any of the numerical method mentioned in the syllabus as a part of Test

### Assessment:

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3
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4. Only Four questions need to be solved.

References:
1. Manish Goyal, Computer Based Numerical and Statistical Techniques, Laxmi Publications
   (P) Ltd, New Delhi
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India(P) Ltd, New Delhi
   Computation, 6th Ed., New Age International (P) Ltd
Objectives
1. To understand Solar Geometry and basic idea of solar energy collection
2. To learn different utilities of solar energy
3. To summarise economics of solar energy collection systems

Outcomes: Learner will be able to…
1. Estimate and quantify available solar radiation
2. Judiciously design the solar energy collection system
3. Understand basic economics of solar energy systems

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs.</th>
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<tbody>
<tr>
<td>01</td>
<td>Description of Solar Radiation and its application for thermal utilities as well as PV utilities, availability, measurement and estimation; Isotropic and anisotropic models; empirical relations</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Flat plate collector, concentrating collector, thermal energy storage: steady state and dynamic analysis, process economics</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Solar water heating: active and passive, building heating and cooling, solar drying, solar desalination, Solar Ponds, Industrial Process heating</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td>Simulation in solar process design, limitations of simulation, design of active systems by f-chart, utilizability method</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Solar photovoltaic systems, PV generators: characteristics and models, load characteristics and direct coupled systems, maximum power point trackers, applications, design procedure, applications of nano materials/technology in solar energy</td>
<td>10</td>
</tr>
<tr>
<td>06</td>
<td>Solar Economics: Application of economic methods to analyze the feasibility of solar systems to decide project/policy alternatives, Net energy analysis and cost requirements for active and passive heating and cooling, electric power generation and for industrial process heating</td>
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References:

Objectives
1. To understand cogeneration and waste heat recovery techniques
2. Learn to check viability of cogeneration and waste heat recovery
3. To summarise economics of such systems

Outcomes: Learner will be able to…
1. Estimate and quantify available waste heat
2. Tap opportunities of waste heat recovery
3. Understand economics of cogeneration and waste heat recovery systems

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<tr>
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<tbody>
<tr>
<td>02</td>
<td>APPLICATION &amp; TECHNO ECONOMICS OF COGENERATION: Cogeneration Application in various process industries. Sizing of waste heat boilers - Performance calculations, Part load characteristics selection of Cogeneration Technologies – Financial considerations - Operating and Investments - Costs of Cogeneration</td>
<td>14</td>
</tr>
<tr>
<td>03</td>
<td>WASTE HEAT RECOVERY: Introduction - Principles of Thermodynamics and Second Law - sources of Waste Heat recovery - Diesel engines and Power Plant etc. Vapour Absorption systems working on waste heat</td>
<td>09</td>
</tr>
<tr>
<td>04</td>
<td>WASTE HEAT RECOVERY SYSTEMS: Recuperators - Regenerators - economizers - Plate Heat Exchangers - Waste Heat Boilers-Classification, Location, Service Conditions, Design Considerations, Unfired combined Cycle - supplementary fired combined cycle - fired combined cycle - fluidised bed heat exchangers - heat pipe exchangers - heat pumps - thermic fluid heaters</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>APPLICATIONS &amp; TECHNO ECONOMICS of Waste Heat Recovery Systems: Applications in industries, selection of waste heat recovery technologies - financial considerations, saving potentials of different waste heat sources - operations and investment costs of waste heat recovery</td>
<td>07</td>
</tr>
<tr>
<td>06</td>
<td>Introduction to tri-generation and quad-generation</td>
<td>04</td>
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References:
7. General Aspects of Energy Management and Energy Audit Book 1, BEE India
Objectives
1. To understand socioeconomic and environment aspects of alternative fuels.
2. To get knowledge of production of alternative fuels.
3. To learn the need for fuel substitution and subsequent benefits.

Outcomes: Learner will be able to…
1. To distinguish between types of alternative fuels.
2. To determine the quality of biofuels.
3. To analyse the impact of alternative fuels on environment.

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<tbody>
<tr>
<td>01 Fossil Fuels to Alternative Fuels</td>
<td>Reserves of Fossil fuels in India and globe, Disadvantages of Fossil fuels, Need of Alternative fuels, Types, Advantages, Sources of Alternative fuels.</td>
<td>10</td>
</tr>
<tr>
<td>02 Advanced Liquid Biofuels</td>
<td>Raw material for biofuel production, Biomass and Waste, First and next generation biofuels, Conversion of lignocellulosic, algal biomass, and waste into biofuels and chemicals, Production of Biodiesel, Bio alcohol, Jatropha Fuel Applications.</td>
<td>12</td>
</tr>
<tr>
<td>03 Advanced Gaseous fuels</td>
<td>Bio-CNG from sugarcane, Synthetic gas SynGas, generation of SynGas through plasma gasification of plastic waste, Applications.</td>
<td>08</td>
</tr>
<tr>
<td>04 Hydrogen Technology</td>
<td>Hydrogen as Alternative fuel, Hydrogen storage, hydrogen liquefaction, ortho and para hydrogen, Non-fossil Natural gas and methane, Applications.</td>
<td>08</td>
</tr>
<tr>
<td>05 Fuel Cells</td>
<td>Principle &amp; operation of Fuel cells, Thermodynamics of fuel cells, types of fuel cells, comparison of fuel cell technologies, stack configurations and fuel cell systems, Applications.</td>
<td>08</td>
</tr>
<tr>
<td>06 Alternative Fuels and Environmental Impact</td>
<td>Climate change, Benefits of alternative fuel to environment, Environmental impact assessment.</td>
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References:
8. Prabir Basu; Biomass gasification and pyrolysis: Practical design and theory; Elsevier, 2010
10. H S Mukunda, Understanding Clean Energy and Fuels from Biomass, Wiley India
12. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd.
**Course Code** | **Course Name** | **Credits**
---|---|---
TEDLO1014 | Steam and Gas Turbines | 04

**Objectives**
1. To understand classification, construction, operation and maintenance of steam turbines
2. To learn gas turbine operation cycles and its performance
3. Understand auxiliary systems in steam as well as gas turbines

**Outcomes:** Learner will be able to…
1. Estimate and quantify performance of stema as well as gas turbine
2. Solve numerical on steam and gas turbine sizing

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<tr>
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<tbody>
<tr>
<td>01</td>
<td>Classification of steam turbines, combination of turbines, overview of turbines, Flow of steam through impulse turbine blades / impulse and reaction turbines blades, Energy losses in steam turbines, governing and performance of steam turbines</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Steam turbine auxiliary systems: turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems</td>
<td>09</td>
</tr>
<tr>
<td>03</td>
<td>Construction, Operation and Maintenance of Steam Turbines</td>
<td>07</td>
</tr>
<tr>
<td>04</td>
<td>Gas Turbine-shaft power cycles, velocity diagram and work done by gas turbine, turbine blade cooling, blade materials, blade manufacture, matching of turbine components,</td>
<td>10</td>
</tr>
<tr>
<td>05</td>
<td>Combustion chambers, requirements, types, factor affecting performance of CC, performance of turbines</td>
<td>07</td>
</tr>
<tr>
<td>06</td>
<td>GT auxiliary systems, operation and maintenance, starting and ignition systems, lubrication systems, Fuel system and controls, operation, maintenance and trouble shooting</td>
<td>09</td>
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4. Only Four questions need to be solved.
References:

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

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

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

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<tr>
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<th>Hrs</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Probability theory</strong>: Probability: Standard definitions and concepts; Conditional Probability, Baye’s Theorem.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Probability Distributions</strong>: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Measures of Dispersion</strong>: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td><strong>Reliability Concepts</strong>: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Failure Data Analysis</strong>: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Reliability Hazard Models</strong>: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td><strong>System Reliability</strong>: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td><strong>Failure Mode, Effects and Criticality Analysis</strong>: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis</td>
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REFERENCES:

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

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

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

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

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

**Taguchi Approach**

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

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**REFERENCES:**

5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
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.

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| 01     | **Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research  
**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis  
**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem  
**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory’s cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | 14 |
| 02     | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | 05 |
| 03     | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation | 05 |
04 **Dynamic programming.** Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems. 05

05 **Game Theory.** Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. 05

06 **Inventory Models:** Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, 05

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**REFERENCES:**

Objective:
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

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<td>Introduction to Cybercrime: Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>Tools and Methods Used in Cyberline Phishing, Password Cracking, 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)</td>
<td>6</td>
</tr>
<tr>
<td>06</td>
<td>Information Security Standard compliances SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.</td>
<td>6</td>
</tr>
</tbody>
</table>

Assessment:

Internal:
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University of Mumbai, ME (Mechanical) Thermal Engineering, Rev 2016
End Semester Theory Examination:
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four 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
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
<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
</tr>
</thead>
</table>
| 01     | Introduction  
1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change. | 03  |
| 02     | Natural Disaster and Manmade disasters:  
2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion  
2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters. | 09  |
| 03     | Disaster Management, Policy and Administration  
3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.  
3.2 Policy and administration: Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process. | 06  |
| 04     | Institutional Framework for Disaster Management in India:  
4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.  
4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard. | 06  |
Financing Relief Measures:
5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO’s in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO’s and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.
5.2 International relief aid agencies and their role in extreme events.

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

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4. Only Four question need to be solved.

REFERENCES:
5. ‘Disaster management & rehabilitation’ by RajdeepDasgupta, Mittal Publications, New Delhi.
6. ‘Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)
**Course Code**: ILO 1018  
**Course Name**: Energy Audit and Management  
**Credits**: 03

**Objectives:**

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

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

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

<table>
<thead>
<tr>
<th>Module</th>
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</thead>
</table>
| 01     | **Energy Scenario:**  
| 02     | **Energy Audit Principles:**  
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     | **Energy Management and Energy Conservation in Electrical System:**  
Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** 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     | **Energy Management and Energy Conservation in Thermal Systems:**  
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 |
Assessment:

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4. Only Four question need to be solved.

REFERENCES:

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

1. Performance test on Spark Ignition engines using Alternate fuels such as ethanol and LPG.
2. Simulation studies of Vapour Absorption System.
3. Simulation studies of Petrol and Diesel engine cycles.
5. Simulation of Adiabatic flame temperature in constant volume heat addition process.
6. Simulation of Adiabatic flame temperature in constant pressure heat addition process
8. Trial / Design of Sterling cycle refrigerator.

Assessment:

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEL102</td>
<td>Renewable Energy Lab</td>
<td>01</td>
</tr>
</tbody>
</table>

The laboratory will focus on the following,

1. Measurement of solar radiation and sunshine hours,
2. Measurement of albedo, UV & IR radiation,
3. Measurement of emissivity, reflectivity, transmittivity,
4. Performance testing of solar flat plate water heater (forced flow & thermosyphon systems)
5. Performance testing solar air heater & dryer & desalination unit,
6. Performance testing of solar thermal concentrators,
7. Characteristics of photovoltaic devices & testing of solar PV operated pump,
8. Energy consumption & lumen measurement of lights & ballasts.
9. Properties of fuel oils & biomass,
10. Testing of Gasifier or Wind machines or Fuel cell

**Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
**Course Code**  | **Course Name** | **Credits**
--- | --- | ---
TEC201  | Modeling and Analysis in Thermal Engineering  | 04

**Objectives**
1. Differentiate design and analysis
2. Understand problem formulation and various modelling and simulation methods to optimise the solution

**Outcomes:** Learner will be able to…
1. Identify design parameters of basic thermal systems
2. Formulate the problem and propose the solution

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<tbody>
<tr>
<td>01</td>
<td>Introduction, Design versus analysis, need for optimization, basic characteristics of thermal systems, analysis, types and examples: energy systems, cooling systems for electronic equipment, environmental and safety systems, air-conditioning, refrigeration and heating systems, heat transfer equipment</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Modeling of thermal systems, basic considerations in design, importance of modeling in design, types of models, mathematical modeling, physical modeling and dimensional analysis</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>Numerical modeling and simulation, development of a numerical model, solution procedure, merging of different models, accuracy and validation, system simulation, methods of numerical simulation, numerical simulation versus real systems</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td>Economic considerations, calculation of interest, worth of money as a function of time, raising capital, economic factors in design, application to thermal systems</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Problem formulation for optimization, basic concepts, optimization methods, optimization of thermal systems, practical aspects in optimal design</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Knowledge based design and additional considerations, knowledge based systems, additional constraints, sources of information</td>
<td>08</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>01</td>
<td>Basics of Fluid Dynamics, Definition and overview of CFD, Advantages and applications, CFD methodology</td>
<td>05</td>
</tr>
<tr>
<td>02</td>
<td>GOVERNING DIFFERENTIAL EQUATIONs: Governing equations for mass, momentum and energy; Navier-Stokes equations; Mathematical behavior of PDE’s viz. parabolic, elliptic and hyperbolic, Initial and boundary conditions, Initial and Boundary value problems. Selection criteria for BC</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>DISCRETIZATION TECHNIQUES: Introduction to Finite difference Method, Finite Volume method and Finite Element method Finite difference methods; Finite difference representation of PDE’s; Solutions to Finite Difference Equations; Implicit, semi-implicit and explicit methods; Errors and stability criteria</td>
<td>11</td>
</tr>
<tr>
<td>04</td>
<td>FINITE VOLUME METHODS: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling; SIMPLE family of algorithms</td>
<td>12</td>
</tr>
<tr>
<td>05</td>
<td>GRID GENERATION : Structured and Unstructured Grids; General transformations of the equations; body fitted coordinate systems; Algebraic and Elliptic Methods; multi block structured grids; adaptive grids</td>
<td>07</td>
</tr>
<tr>
<td>06</td>
<td>TURBULENCE MODELING: Effect of turbulence on governing equations; RANS, LES and DNS Models</td>
<td>07</td>
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References:

Course Code | Course Name | Credits
---|---|---
TEC203 | Heat Exchanger Design and Performance | 04

Objectives
1. Impart knowledge of sizing and designing of various heat exchangers using various methods
2. Learn performance analysis and maintenance aspects of heat exchanging equipments

Outcomes: Learner will be able to…
1. Customize sizing and/or designing of heat exchangers
2. Identify efficacy of conventional or compact heat exchangers for specific purpose

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<tr>
<th>Module</th>
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<tbody>
<tr>
<td>01</td>
<td>Constructional Details and Heat Transfer: Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators - Industrial Applications, Methodology, Design consideration, Temperature Distribution and its Implications - LMTD - Effectiveness</td>
<td>10</td>
</tr>
<tr>
<td>02</td>
<td>Flow Distribution and Stress Analysis: Effect of Turbulence – Effect of Fouling-Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures</td>
<td>8</td>
</tr>
<tr>
<td>04</td>
<td>Condensers and Evaporators Design: Design of Surface and Evaporative Condensers - Design of Shell and Tube - Plate Type Evaporators</td>
<td>8</td>
</tr>
<tr>
<td>05</td>
<td>Cooling Towers: Types- Spray Design - Selection of Fans- Testing and Maintenance of cooling towers, Compact cooling towers, cooling tower performance variable</td>
<td>8</td>
</tr>
<tr>
<td>06</td>
<td>Design of Special Purpose Heat Exchangers: corrosive environment. Marine/space applications, compact heat exchanger</td>
<td>8</td>
</tr>
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4. Only Four questions need to be solved.
References:

5. Mojtaba Sabet, Cooling tower fundamentals and best design practices, Outskirts Press, 2014
Objectives
1. Impart basic knowledge of low temperature generation, difficulties in maintaining low temperature and solutions
2. Understand applications of cryogenic refrigeration
3. Understand storage of cryogenic liquids and equipments, instruments used

Outcomes: Learner will be able to...
1. Understand use of cryogenic systems, realtime difficulties in storing cryogenic liquids
2. Identify effects of various components on cryogenic system performance

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<tr>
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<tr>
<td>01</td>
<td><strong>Introduction to Cryogenic systems:</strong> Present areas involving Cryogenic Engineering, Low temperature properties of materials-Mechanical properties, Thermal properties, Electrical and Magnetic Properties, Properties of Cryogenic Fluids, Properties of solids at cryogenic temperatures; Superconductivity.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td><strong>Liquefaction Systems</strong>– system performance parameters, thermodynamically ideal liquefaction system, Production of Low temperatures- Joule Thomson effect, adiabatic expansion, Liquefaction systems for gasses other than neon, Hydrogen and Helium - Recuperative – Simple Linde – Hampson, precooled linde – Hampson, Linde dual pressure, Claude, Cascade, Heylandt, Kapitza, Liquefaction systems for gases neon, Hydrogen and Helium - Recuperative - Collins, Simon; Regenerative – Sterling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td><strong>Cryogenic Refrigeration Systems:</strong> Ideal Refrigeration systems, Refrigerators for temperatures above 2k- Joule –Thomson Refrigeration systems, Philips refrigerator, Solvay refrigerator, Vuilleumier refrigerator, Gifford-Mac Mohan Refrigerator, Regenerator Refrigerators for temperatures below 2k- Magnetic cooling, Magnetic refrigeration, Magneto-caloric refrigerator, $^3$He-$^4$He Dilution refrigerators, thermal valves.</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Instrumentation, measurement systems &amp; cryogenic Insulations</strong>- Temperature, Pressure, Flow rate, Fluid quality, Liquid level measurement systems. <strong>Cryogenic Insulations</strong> Expanded foams, Vacuum insulation, Evacuated powders and fibrous materials insulation, Gas filled powders and fibrous materials, opacified powder, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td><strong>Storage of cryogenic liquids:</strong> Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Cryogenic equipments &amp; Cryogenic Applications</strong>- Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders, Turbo alternators; Effect of component inefficiencies on system performance, system optimization, cryocoolers</td>
<td>08</td>
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</table>
Cryogenic Applications - Cryogenic Engineering applications in energy, aeronautics, space, industry, biology & medicine, food preservation, transport, cryopumping.

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References:

3. A Bose and P Sengupta, Cryogenics: Applications and Progress, TMH
5. Herald Weinstock, Cryogenic Technology, 1969
7. T.M. Flynn, Cryogenic Engineering, Marcel Dekker
9. J.G. Weisend II (Editor), Handbook of Cryogenic Engineering, Taylor and Francis
11. C.A. Bailey(Editor), Advanced Cryogenics, Plenum Press.
## Course Code
TEDLO 2022

## Course Name
Internal Combustion Engine Design

## Credits
04

### Objectives
1. Understand design considerations in IC Engine
2. Learn optimization of engine components and prepare working drawings
3. Learn design aspects of engine accessories and mountings

### Outcomes: Learner will be able to…
1. Design complete engine with all its components, mountings and accessories
2. Quantify the effect of change in fuel on engine design and its performance

### Module | Detailed Contents | Hrs.
--- | --- | ---
01 | General Considerations in Engine Design: Principle of similitude, choice of cycle, speed, fuel, bore and stroke, cylinder arrangement, choice of material, stress and fatigue considerations, design for manufacture | 8
02 | Design of Major Components: Piston system, connecting rod assembly, crankshaft system, valve gearing, stress analysis | 8
03 | Design of Other Components: Inlet and exhaust manifolds, cylinder block, cylinder liner, cylinder head, gaskets, crankcase, Engine foundations and mountings, bearings, flywheel. Turbocharger, supercharger, computer controlled fuel injection system | 10
04 | Design of Two-Stroke Engines: Arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline and marine diesel engines | 10
05 | Optimization of Engine Components, Preparation of working drawings of designed components | 10
06 | Multi-fuel engines, Effect of change in fuel on engine design and performance | 6

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References:

Objectives
1. Study basic concepts and principles of turbo machinery
2. Learn performance analysis of centrifugal as well as axial machines like fans, blowers and compressors

Outcomes: Learner will be able to…
1. Read and understand performance characteristic curves of various turbo machines
2. Design blowers and fans for specified applications
3. Identify suitable control and testing methods for blowers and fans

<table>
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<tr>
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<tbody>
<tr>
<td>01</td>
<td><strong>Basic concepts of turbo machines:</strong> Definition of Turbo machine, classification; Euler's pump equation and Euler's turbine equation, dimensional analysis applied to hydraulic machines and compressible flow machines.</td>
<td>07</td>
</tr>
<tr>
<td>02</td>
<td><strong>Principles of turbo machinery:</strong> Transfer of energy to fluids, Performance characteristics, fan laws, selection of centrifugal, axial, mixed flow, Axial flow machines</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td><strong>Analysis of centrifugal Machines:</strong> Centrifugal Compressors and Blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency, flow through inlet nozzle, impeller, diffusers, casing, leakage, disc friction, mechanical losses, cross flow fans</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td><strong>Analysis of axial flow Machines:</strong> Axial flow fans and compressors: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist, stage design, surge, choking and stall, stator and casing, mixed flow impellers. Design considerations for supersonic flow</td>
<td>12</td>
</tr>
<tr>
<td>05</td>
<td><strong>Design and applications of blowers and Fans:</strong> Special design and applications of blower induced and forced draft fans for air-conditioning plants, cooling towers, ventilation systems, booster systems.</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Testing and control of Blowers and Fans:</strong> Performance testing, noise control, speed control, throttling control at discharge and inlet.</td>
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References:

6. Budugur Lakshminarayana, Fluid Dynamics and heat Transfer of Turbomachinery, John Wiley and Sons, Inc
**Course Code**: TEDLO2024  
**Course Name**: Non-Conventional Power Plants  
**Credits**: 04

**Objectives**
1. Understand need, usefulness and feasibility of non conventional power plants in global as well as Indian context
2. Learn environmental and socioeconomic impacts of such power plants

**Outcomes**: Learner will be able to…
1. Understand power crunch and propose green solution to overcome it
2. Evaluate potential opportunities in non conventional power sector

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<tr>
<td>01</td>
<td>Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.</td>
<td>08</td>
</tr>
<tr>
<td>02</td>
<td>Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal conversion devices, Economics and social considerations, Design considerations of component selection. Solar photovoltaic power plants, photovoltaic technology, Design of a photovoltaic system, economics and costing. Application as a distributed power supply strategy</td>
<td>08</td>
</tr>
<tr>
<td>03</td>
<td>Wind energy: Wind energy potential measurement, wind electric generator component design, economics and demand side management, energy wheeling, and energy banking concepts.</td>
<td>08</td>
</tr>
<tr>
<td>04</td>
<td>Biogas: properties of biogas (Calorific value and composition), biogas plant technology and status</td>
<td>08</td>
</tr>
<tr>
<td>05</td>
<td>Other plants: Fuel cell based power plants, tidal and wave energy plant design, OTEC power plants. Geothermal energy: hot springs and steam ejection site selection, power plants, and economics.</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td>Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms</td>
<td>08</td>
</tr>
</tbody>
</table>

**Assessment:**

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

Course Code: ILO 2021
Course Name: Project Management
Credits: 03

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

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

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

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

References:
1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Ed.
4. Gopalan, Project Management, Wiley India
### Course Code: ILO 2022  
### Course Name: Finance Management  
### Credits: 03

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
</table>
| 01     | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.  
**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.  
**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market  
**Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | 06 |
| 02     | **Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.  
**Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting. | 06 |
| 03     | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.  
**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis. | 09 |

University of Mumbai, ME (Mechanical) Thermal Engineering, Rev 2016  
60
| 04 | **Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)  
**Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity’s Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | 10 |
| 05 | **Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.  
**Capital Structure:** Factors Affecting an Entity’s Capital Structure; Overview of Capital Structure Theories and Approaches—Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure | 05 |
| 06 | **Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity’s Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon’s Approach, Walter’s Approach, and Modigliani-Miller Approach | 03 |

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<tbody>
<tr>
<td>01</td>
<td><strong>Overview Of Entrepreneurship:</strong> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship</td>
<td>04</td>
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<tr>
<td>02</td>
<td><strong>Business Plans And Importance Of Capital To Entrepreneurship:</strong> Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur <strong>Entrepreneurship And Business Development:</strong> Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations</td>
<td>09</td>
</tr>
<tr>
<td>03</td>
<td>Women’s Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises</td>
<td>05</td>
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<tr>
<td>04</td>
<td><strong>Indian Environment for Entrepreneurship:</strong> key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc</td>
<td>08</td>
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<tr>
<td>05</td>
<td><strong>Effective Management of Business:</strong> Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing</td>
<td>08</td>
</tr>
<tr>
<td>06</td>
<td><strong>Achieving Success In The Small Business:</strong> Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business</td>
<td>05</td>
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References:
1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikha Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in
Course Code | Course Name | Credits
---|---|---
ILO2024 | Human Resource Management | 03

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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</thead>
</table>
| 01 | **Introduction to HR**  
- Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.  
- Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 5 |
| 02 | **Organizational Behavior (OB)**  
- Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues  
- Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness  
- Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior.  
- Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);  
- Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.  
- Case study | 7 |
| 03 | **Organizational Structure &Design**  
- Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.  
- Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.  
- Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 6 |
<table>
<thead>
<tr>
<th>04</th>
<th>Human resource Planning</th>
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</thead>
<tbody>
<tr>
<td>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.</td>
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<tr>
<td>• Training &amp; Development: Identification of Training Needs, Training Methods</td>
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<table>
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<tr>
<th>05</th>
<th>Emerging Trends in HR</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes &amp; transformation in HR. Organizational Change, Culture, Environment</td>
<td></td>
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<tr>
<td>• Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.</td>
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<table>
<thead>
<tr>
<th>06</th>
<th>HR &amp; MIS</th>
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</thead>
<tbody>
<tr>
<td>• Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries</td>
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<tr>
<td>• Strategic HRM</td>
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<tr>
<td>• Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</td>
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<tr>
<td>• Labor Laws &amp; Industrial Relations</td>
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<tr>
<td>• Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</td>
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</table>

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

**Objectives:**

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

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hrs</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Professional Ethics and Business:</strong> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business</td>
<td>04</td>
</tr>
</tbody>
</table>
| 02     | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy  
**Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08  |
| 03     | **Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm’s Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy  
**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06  |
| 04     | **Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection.  
Trajectory of Corporate Social Responsibility in India | 05  |
| 05     | **Corporate Social Responsibility:** Articulation of Gandhian Trusteeship  
Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | 08  |
| 06     | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08  |
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References:
1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
<table>
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<tr>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ILO2026</td>
<td>Research Methodology</td>
<td>03</td>
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</table>

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

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
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<tbody>
<tr>
<td>01</td>
<td><strong>Introduction and Basic Research Concepts</strong></td>
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<tr>
<td></td>
<td>1. Research – Definition; Concept of Construct, Postulate, Proposition, Thesis,</td>
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<td></td>
<td>Hypothesis, Law, Principle. Research methods vs Methodology</td>
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<td></td>
<td>1.2 Need of Research in Business and Social Sciences</td>
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<td>1.3 Objectives of Research</td>
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<td>1.4 Issues and Problems in Research</td>
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<td>1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</td>
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<td>02</td>
<td><strong>Types of Research</strong></td>
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<td>2.1. Basic Research</td>
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<td>2.2. Applied Research</td>
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<td>2.3. Descriptive Research</td>
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<td>2.4. Analytical Research</td>
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<td>2.5. Empirical Research</td>
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<td>2.6 Qualitative and Quantitative Approaches</td>
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<td>03</td>
<td><strong>Research Design and Sample Design</strong></td>
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<td></td>
<td>3.1 Research Design – Meaning, Types and Significance</td>
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<td>3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages</td>
<td>07</td>
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<td>in Sample Design Sampling methods/techniques Sampling Errors</td>
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<tr>
<td>04</td>
<td><strong>Research Methodology</strong></td>
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<td>4.1 Meaning of Research Methodology</td>
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<td>4.2. Stages in Scientific Research Process:</td>
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<td>a. Identification and Selection of Research Problem</td>
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<td>b. Formulation of Research Problem</td>
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<td>c. Review of Literature</td>
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<td>d. Formulation of Hypothesis</td>
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<td>e. Formulation of research Design</td>
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<td>f. Sample Design</td>
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<td>g. Data Collection</td>
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<td>h. Data Analysis</td>
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<tr>
<td></td>
<td>i. Hypothesis testing and Interpretation of Data</td>
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<td>j. Preparation of Research Report</td>
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<tr>
<td>05</td>
<td><strong>Formulating Research Problem</strong></td>
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<td>5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis</td>
<td>04</td>
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<td>06</td>
<td><strong>Outcome of Research</strong></td>
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<td>6.1 Preparation of the report on conclusion reached</td>
<td>04</td>
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<td>6.2 Validity Testing &amp; Ethical Issues</td>
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<td>6.3 Suggestions and Recommendation</td>
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**References:**
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2\textsuperscript{nd}ed), Singapore, Pearson Education
Objectives:
1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

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

<table>
<thead>
<tr>
<th>Module</th>
<th>Detailed Contents</th>
<th>Hr</th>
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</thead>
<tbody>
<tr>
<td>01</td>
<td><strong>Introduction to Intellectual Property Rights (IPR):</strong> Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.</td>
<td>05</td>
</tr>
<tr>
<td>02</td>
<td><strong>Importance of IPR in Modern Global Economic Environment:</strong> Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</td>
<td>07</td>
</tr>
<tr>
<td>03</td>
<td><strong>Enforcement of Intellectual Property Rights:</strong> Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement</td>
<td>07</td>
</tr>
<tr>
<td>04</td>
<td><strong>Indian Scenario of IPR:</strong> Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.</td>
<td>07</td>
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<tr>
<td>05</td>
<td><strong>Emerging Issues in IPR:</strong> Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.</td>
<td>07</td>
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<tr>
<td>06</td>
<td><strong>Basics of Patents:</strong> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent</td>
<td>07</td>
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<tr>
<td>07</td>
<td><strong>Patent Rules:</strong> Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)</td>
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Assessment:
Internal:
Assessment consists of two tests out of which; one should be compulsory class test (on minimum Two Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Theory Examination:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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

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

2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
**Course Code**: ILO2029  
**Course Name**: Environmental Management  
**Credits**: 03

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

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

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

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4. Only Four questions need to be solved.
References:
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclllan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
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<tbody>
<tr>
<td>TEL201</td>
<td>CFD Lab</td>
<td>01</td>
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</table>

The laboratory will focus on the following:

1. Give adequate exposure to commercially available analysis packages
2. Train students to write simple codes in MATLAB, C, C++ for control volume analysis
3. Give students an understanding of the working of a complete code through exercises on simple flows

The laboratory assignments should be based on the following:

1. Simulate and solve 2-d and 3-d steady and unsteady flows using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX, etc.
2. Write codes for 1-d and 2-d steady conduction with and without source and do the post processing to verify with analytical results
3. Write codes for steady, 2-d conduction-advection problems and do the post processing to verify with analytical results

**Assessment:**

**End Semester Examination:** Practical/Oral examination is to be conducted by pair of internal and external examiners
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<tbody>
<tr>
<td>TEL202</td>
<td>Measurement &amp; Virtual Instrumentation Lab</td>
<td>01</td>
</tr>
</tbody>
</table>

**Topic**

I. Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature

II. Virtual Instrumentation

   a. Simulation of any system with Virtual Instrumentation (VI) environment using any suitable software

   b. Interfacing of sensors used for measuring above mentioned parameters in I with VI software and measurement of these parameters on any laboratory model or actual working system

III. Demonstration of interfacing of VI software with suitable generic hardware

**Assessment:**

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

- Seminar should be based on thrust areas in Mechanical Engineering (Thermal Engineering aspect is appreciated)
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literature and understand the topic and compile the report in standard format as per University Guidelines for report writing and present in front of pair of Examiners appointed by the Head of the Department/Institute of respective Programme.

- Seminar should be assessed jointly by the pair of Internal and External Examiners

- Seminar should be assessed based on following points
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation
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.